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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK.....265, 277
The Reconstructed Canyon Ferry Dam, near Helena, Montana (illustrated)..... 266
The Second Fire in the Fireproof Horne Store Building, Pittsburg, Pa. (illustrated)..... 267
The Auxiliary Hydraulic Pumping Plant of the Peoria Water-Works Co., Peoria, Ill. (illustrated). 268
Progress on the New Water-Works for Cincinnati, O. (with two-page plate)..... 270
Notes on Garbage Disposal at Cincinnati..... 271
The Viagraph: An Instrument for Recording Graphically Inequalities in Road Surfaces (illustrated).. 271
The Iron Ore Deposits of Dunderland, Norway..... 276
The Disaster to the Water-Power Plant at Hannawa Falls, N. Y. (illustrated)..... 277
Smoke Prevention on the Railways Entering Chicago 278
Book Reviews..... 280
EDITORIAL NOTES..... 272
Rapid Growth of the American Society of Mechanical Engineers—The Prospect of Nicaragua Canal Legislation in Congress.
EDITORIAL:
Municipal Cleansing in Great Britain..... 272
LETTERS TO THE EDITOR.....273, 276
Mending Steel Tapes—Two Definitions of Entropy—Making Railway Embankments by Filling Trestles—Thoughts Concerning the Austin Dam Failure—The Progressive Combustion of Gunpowder and the Credit for Its Development (illustrated)—Pavement Foundations in Albany, N. Y.—Notes and Queries.

THE CHICAGO RIVER BY-PASS extending from above Jackson Boulevard to below Van Buren St. was opened April 6, thus increasing the waterway and reducing the current in the river. The by-pass is a curved tunnel passing under the railway freight yards and west of the piers of the Jackson Boulevard, Metropolitan Elevated Ry. and Van Buren St. drawbridges. It is 50 ft. wide and 16 ft. deep, having concrete walls with transverse roof girders supporting concrete arches. A similar but shorter by-pass just above, at Adams St., was opened in November, as noted in our issue of Nov. 30, 1899. The object of these channels is to increase the capacity of the river at points where no open cut could be made. Their construction was described and illustrated in an issue of Feb. 16, 1899.

THE HARBOR IMPROVEMENTS OF PORT ARTHUR, Manchuria, which are proposed by the Russian Government, afford an opportunity to American builders of dredges and contractors for dredging work. At present the harbor of Port Arthur has an entrance channel which, with a moderate amount of dredging, is about 24 ft. deep at mean low tide. The narrowest part of this entrance is 830 ft. wide at low tide. It is apparently proposed to create a second or alternative entrance 700 ft. wide and 30 ft. deep and to excavate a new harbor. The dredging will comprise some 45,720,000 cu. yds. of material, consisting of mud, earth and sand mixed with shells in places. According to the best information available practically all of this material is of a character which can be readily handled by hydraulic dredges. It has been suggested that about 7,620,000 cu. yds. of the excavated material shall be deposited on the tidal flats adjacent to the harbor and the remainder towed to sea and dumped. These tidal flats, it is stated, however, will accommodate about 30,480,000 cu. yds., and the proposition has been advanced that they should be filled and thus utilize the land made as well as reduce the amount to be towed to sea and cheapen the cost of the work in other ways.

THE APPEAL OF EX-CAPT. O. M. CARTER to the U. S. Supreme Court was dismissed by that body on April 23. Apparently no further legal technicalities can be taken advantage of by his counsel to further postpone the execution of the sentence of imprisonment which was allotted to him by a court martial on April 30, 1898, almost two years ago. During the time which intervened from the verdict of the court martial to its final approval by the President on Oct. 1, 1899, Captain Carter was nominally under arrest, but lived at a club in New York city. Since that time he has been confined in a cell on Governor's Island.

THE PROPOSED ST. PETERSBURG-ODESSA RAILway, estimated to cost about $90,000,000, is being bid for by Philadelphia and Richmond capitalists. Mr. E. F. Walker, of Philadelphia, and Mr. J. H. McCleary, of Richmond, Va., sailed, on April 18, for London to meet Russian railway officials and to make an offer for the work after studying the plans.

A LARGE FLOATING DRY-DOCK is proposed by the Morse Iron Works & Dry-Dock Co., says the Brooklyn "Eagle," to be built at the foot of 55th St., Brooklyn. The dock will be 700 ft. long, and provision will be made for adding 100 ft. if found expedient. The basin will extend out 1,400 ft. to the edge of the new 40-ft. channel. The plans for the pontoon dock show seven sections, each 80 ft. long, with a body 120 ft. wide and drawing 15½ ft.; each pontoon is supposed to have a lifting capacity of 2,500 tons. On each section will be two centrifugal pumps, of a capacity of 6,000 gallons per minute, driven by a 50-HP. electrical motor. The contract for construction has been let to Mr. James D. Leary. The President and Treasurer of the Dock Co. is Mr. E. P. Morse; Vice-President and Secretary, Mr. C. G. Street; Directors, Messrs. W. L. Chapman, W. A. Turner and Edmund L. Mooney.

THE PEARL HARBOR NAVAL STATION, for which plans have been made by the Navy Department, is described as follows: Pearl Harbor is on the Island of Oahu, and the Department wants four tracts of land there aggregating 1,880 acres, for a naval rendezvous, repair plant and coaling station. While there is abundant water inside, the narrow entrance must be improved at a comparatively small cost. The bill now before the Senate appropriates $400,000 for dredging and improving the channel for the safe entrance of large warships; and transfers from the army to the navy $100,000 appropriated in March, 1899, for a similar purpose. The development of this harbor is also needed for commerce, as the present harbor is too small to meet the demands of existing trade.

THE 16-IN. GUN now being made at the Watervliet Arsenal will weigh 126 tons, without the carriage. It will be 49 ft. 6 ins. long; 6 ft. 2 ins. diameter at breech, and 16 ins. caliber. The theoretical range of this gun is 20.76 miles, with a 2,370-lb. projectile. The latter is 64 ins. long, and will be propelled by a powder charge of 1,060 lbs., giving it an initial velocity of 2,600 ft. per second. This would mean a muzzle penetration of 41.6 ins. of wrought iron. At the maximum range and elevation the calculated breech pressure is 36,000 lbs. per sq. in.

ONE OF THE WELLAND CANAL LOCKS was damaged on April 21 by the explosion of a charge of dynamite midway between the gates. One or both sets of gates will have to be replaced, but otherwise the damage is claimed to be slight. The mischief was ascribed to grain-scoopers of Buffalo, who would have profited by the closing of the canal to the grain traffic, but this statement is now denied, and the two men arrested will claim that their offense was a political one.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the line of the Baltimore & Ohio Southwestern R. R. near Dillsborough, Ind., on April 19. A freight engine and five cars went through a bridge, killing two men and injuring one. The bridge was undergoing repairs.

THE TURKISH TORPEDO-BOAT "SCHAMYL" is reported to have blown up in the harbor of Beyrout, Syria, on April 21, resulting in the loss of 23 lives.

HEAVY RAINS are reported from many parts of the country, and great damage has been done to bridges and dams. On April 17 a break occurred in the dam on the Nueces River at Corpus Christi, Tex. On the same date the dam of the Meridian Water-Works Co., at Meridian, Miss., gave way and that city is surrounded by water on three sides. The bridge over the West Pascagoula River, near Scranton, Ala., on the line of the Louisville & Nashville R. R., was washed away on April 22, and all railway lines in Mississippi and Alabama are much crippled by washouts and the loss of bridges. Heavy rains are reported from Bangor, Me. The water is over 9 ft. on the water-works dam on the Penobscot River.

FOREST-FIRES, now raging in Northern Minnesota and in Manitoba, are believed to have been very destructive to life and property. The fire has invaded the proposed National Park of Minnesota, in the Leech Lake region, and the small towns there are in great danger. For 100 miles northwest of Duluth the country is said to be one vast furnace, with little chance of escape for the settlers within these limits. Lumbermen predict the greatest fire known in the history of Minnesota.

A COMMITTEE ON ELECTROLYSIS was established by the Ohio Gas Light Association, at its recent annual meeting, consisting of Messrs. R. Montgomery, Youngstown, O.; John Franklin, Cincinnati, O.; and Emil G. Schmidt, Sandusky, O. The committee was instructed to take up the subject in conjunction with other organizations also working on it and to report at the next meeting.

SUBWAYS FOR PIPES AND WIRES in New York city, or pipe galleries, as the Rapid Transit Commission calls them, have been ordered built along the line of underground railway on Elm St., from Worth St. to Astor Place. Detailed plans and specifications for the subways have also been ordered. In our issue of March 15, 1900, we published an editorial review of subways in other cities of the world and gave some of the reasons why they should be built in New York.

THE THOROUGH SEWERAGE AND DRAINAGE of New Orleans now seems to be assured, the State of Louisiana having just voted certain constitutional amendments necessary to make possible the action already taken by the city to that end. A Sewerage and Water Commission has already been established. A municipal water plant is also contemplated.

FILTERS FOR THE PUBLIC SCHOOLS OF PHILAdelphia are provided for by an ordinance just signed by the mayor. The ordinance appropriates $35,000 for the purpose and provides that two styles of filters shall be bought, 50% of each, the selection to be made by the Board of Health. This peculiar provision is said to be a compromise between the boards of health and education, each of which desired to install a type of filter chosen by itself.

SUITS AGAINST THE DIVERSION OF UNDERground water from Freeport Creek, L. I., have been brought against the city of New York by five baymen, who claim that since the Brooklyn conduit, wells and pumping stations were put in operation in or about 1890 the water in the creek has been lowered to the great damage of their occupation as oystermen and boatmen. They ask the court to enjoin the operation of the pumping station and conduit in such a manner as to prevent the natural flow of water to the creek; or for damages to the amount of $15,000 each, if the diversion is to be continued.

A FULL METER SYSTEM FOR HARTFORD, CONN., has been recommended by a special committee of the Board of Water Commissioners and adopted by the board. The committee stated that the consumption was already 115 gallons a day, while the dry weather supply is only 80 gallons; that the 500 meters in use have given good results; that without meters the supply must be increased at an annual cost of $40,000, while for $150,000 the whole city might be metered. The committee also says that even if the supply be increased that step will only postpone the universal meter system, "because of the correctness of the principle." It "believes that meters act as mechanical inspectors of plumbing and as such are less objectionable to consumers than individual inspectors, as well as being more effectual and reliable." The meters will be placed and maintained at the expense of the water department.

DANGER OF LEAD POISONING AT LOWELL, MASS., from the water from the groups of wells known as the Cook and the Hydraulic is considered so great by Prof. Chas. Harrington, of Harvard University, that he has recommended an entire discontinuance of their use and an extension of the Boulevard group to make up the deficiency in the supply. The Cook wells, he thinks, should be held in reserve for emergency use, since the danger from lead poisoning comes from continuous rather than intermittent use of the water.

A REPORT AGAINST REBUILDING THE AUSTIN dam has been made by a citizens' committee, appointed at a recent mass meeting. From rough estimates by Prof. T. U. Taylor, Assoc. M. Am. Soc. C. E., and from Mr. Patterson, Superintendent of the city water and light plants, the committee thinks $500,000 would be required to rebuild the dam, headgate masonry and power-house, against $250,000 for a new steam plant for both light and water, located at the new filter galleries, nearer the city. Professor Taylor suggested that in filling the gap in the dam a masonry wall should be carried 10 ft. below the original foundation; that such a wall should be built along the foot of the up-stream face of the dam; and that the portion of the dam left standing at the east end, as well as the headgates, should be entirely reconstructed. These suggestions by the professor, as we understand it, are quite informal.

THE TRANSPORTATION OF TROOPS over land-grant railways is causing trouble, owing to the ruling of the Comptroller of the U. S. Treasury that troops should be hauled on a party-rate basis. The roads claim that they are entitled to regular first-class fare, and they propose to fight the case in the courts. The appropriation act provided that in the transport of troops a deduction of 50% should be made from the regular tariff rate on the land-grant portions of the railways affected. The roads do not object to the land-grant clause, but they insist that this 50% deduction should not be made on a party-rate basis. A test case is to be made by the Northwestern Railway, and the Rock Island, Burlington, Santa Fe, St. Paul and Illinois Central are interested.

THE RECONSTRUCTED CANYON FERRY DAM, NEAR HELENA, MONT.

A timber crib dam, 29 ft. high above mean low water, was completed in 1898 at Canyon Ferry, Mont., by the Helena Water & Electric Power Co. A partial failure of the apron made its reconstruction necessary. The dam had three steps on the lower side, designed to break the force of the water. First there was a timber apron 14 ft.

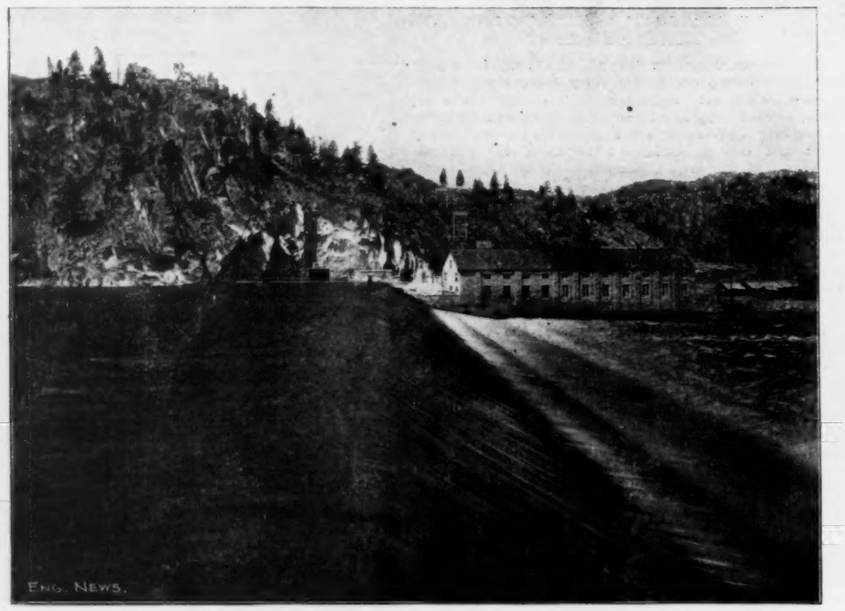


FIG. 1.—CANYON FERRY DAM, NEAR HELENA, MONT., AFTER RECONSTRUCTION.
M. H. Gerry, Jr., Superintendent and Engineer, Helena Water & Electric Power Co.

wide, then two steps with 10-ft. rises and tread, then a rise of 7½ ft. to the crest. The rises were inclined about 3 on 1. Below and nearly level with the apron quite a large area was filled in to the water line with large stones, being confined on the down-stream side by a close row of round piles. Both above and below the timber crib there was a row of triple-lap 3 × 12-in. sheet-piling, driven 12 ft. below the bed of the river; or where in hard material until the pile was in danger of splitting. The timber crib was some 55 to 60 ft. wide at the base and 485 ft. long between the masonry abutments. The crib-work rested on the bed of the river, "which is compact material composed of gravel and granite sand, and practically impervious to water." The design of the original structure is shown at the left in the accompanying cross-section of the reconstructed dam, the section being taken at a point where there was no deformation.

Soon after the dam was completed a heavy freshet proved that a part of the apron was not strong enough to withstand the force of the falling water, as designed. The water, according to the "Proceedings of the Twelfth Annual Meeting of the Montana Society of Engineers" (Jan., 1899, p 5),

> struck at the extreme outer edge of the first step, and from there had a clear drop to the outer edge of the lower step, the force being sufficient to wash out the lower step in a short time, and to soon make a large excavation, the dam settling and springing out of line from 4 to 5 ft.

The apron and lower steps were reconstructed with a series of slopes, instead of steps, as is shown by the accompanying illustrations, kindly sent us by Mr. M. H. Gerry, Jr., of Canyon Ferry, Mont., superintendent and engineer of the Helena Water & Electric Power Co.

We have received the following information from Mr. Gerry, regarding the original dam and its reconstruction:

> The partial failure in 1898 was due to undermining on the down-stream side of the dam. With about 5 ft. of water over the crest, the velocity of approach became so great that the water, after striking the first step passed clear of the other aprons, and struck with great force on the river bed, which was protected only by rip-rap; a scour started at a point about 175 ft. from the west abutment, and before it could be stopped by dumping rock from a cable stretched across the river, a portion of the dam, about 200 ft. in length, settled over and out of line. The maximum settlement on the crest was about 1 ft.; the greatest down-stream movement of the crest line at any point was about 5 ft.; the maximum movement of the down-stream toe was about 6 ft. The structure simply settled over into the cut; parts of the old aprons and timber were removed, and after the new extension was in place, all of the cribbing, both old and new, was carefully filled with rock. The new cribbing was heavily anchored and tied together, and also to the old structure, by means of 1¼-in. anchor bolts, and ⅞-in. square drift bolts. About 1,500,000 ft. of timber, and about 8,000 yds. of rock were used in the reconstruction, and the time occupied was about six months. During the high water of 1899 (the highest on the Missouri River for many years) about 7½ ft. of water passed over the reconstructed dam without injury.
>
> Our plant has now been in operation about thirty months, transmitting power by means of alternating current at 12,000 volts, about 18 miles to two sub-stations in and about the city of Helena. It has operated smoothly and with entire success; our only serious mishap being with the dam. This, however, did not interfere with our operation.

The construction of the original dam was described in a paper by Mr. Theron M. Ripley, read before the Montana Society of Civil Engineers, and published in the Journal of the Association of

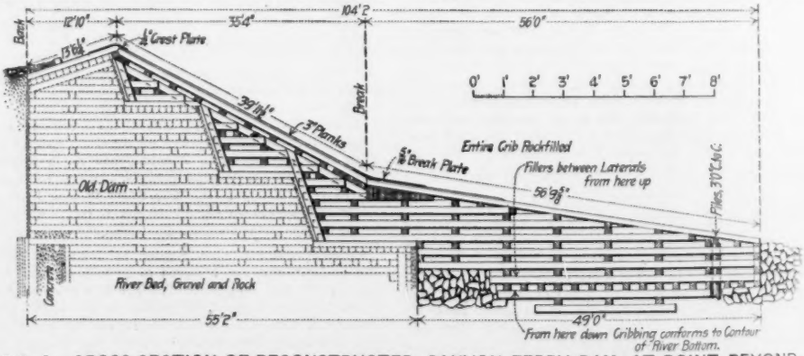


FIG. 2.—CROSS-SECTION OF RECONSTRUCTED CANYON FERRY DAM, AT POINT BEYOND DEFORMATION.

Engineering Societies for May, 1898. Mr. J. T. Fanning, M. Am. Soc. C. E., of Minneapolis, Minn., was consulting engineer, and made all the plans for the work, according to Mr. Ripley.

On submitting proof of this article to Mr. Fanning, he kindly sent us the following comments:

> Mr. Ripley's sectional illustration of the dam, made from the original drawing, shows the apron to have been designed with eight depths of 10 × 12-in. timbers, placed alternately across and up and down stream, forming cribs. The lines of up and down stream timbers extend from the lower to the upper sides of the dam, and form a part of the base series of cribs of the whole dam, making the apron an integral part of the whole structure. This apron was covered with two layers of 10 × 12-in. timbers, forming a solid floor 20 ins. thick. This structure was deemed by the designer substantial enough to withstand a sheer fall of the water through the 27½ ft., even if it had not been modified in force by one or more of three intermediate steps.
>
> Mr. M. H. Gerry, Jr., Superintendent, who supervised the reconstruction of the apron, but who was not present during the original construction, informed the designer that the examination of timbers at ends of the break indicated that the part of the apron that was broken was not timbered as deep as the plan showed. The break in the apron was on the side of the river where the water was shallowest.
>
> The apron crib was filled with stone. The design provided a flooring in the bases of alternate cribs to retain the stone filling in the cribs and weight them and check vibration in case of any underscouring. It appears that these floor plank were, in construction, omitted entirely from the bases of the cribs.

Mr. Fanning also informs us that he built an apron in connection with a large dam in the Mississippi River about ten years ago which is almost identical with the design for the Missouri River dam, and that it has proved so complete a success that he did not deem the Missouri River dam to be experimental in its design. He had, however, opportunity to give personal supervision to the construction of the Mississippi River dam.

It is interesting to note that there are four 12-ft. steel penstocks and one 4½ ft. in diameter, connected with the Canyon Ferry power development. Also that another crib dam in Montana sprung out of line at its crest in 1898, in part because of undue settling of the filling placed in the cribs. This structure is located on the Big Hole River, about 30 miles from Butte. It was about 60 ft. high. The structure and its failure were described by Mr. M. S. Parker, M. Am. Soc. C. E., of Butte, Mont., in a paper read before the Montana Society of Civil Engineers in January, 1899, and published both in the report of that body for 1899 and in the Journal of the Association of Engineering Societies for April, 1899.

THE SECOND FIRE IN THE FIREPROOF HORNE STORE BUILDING, PITTSBURG, PA.

In our issue of May 20, 1897, we described the partial destruction by fire of the fireproof department store building of Joseph Horne & Co., of Pittsburg, Pa. As many of our readers will remember, this was at that time the most notable instance in which modern systems of fireproofing had been subjected to the test of actual conflagration, and it aroused a considerable amount of discussion among engineers and others interested in fireproof building construction. This discussion was pretty thoroughly threshed out in our issues of May 20 and 27, and July 1 and 15, 1897, and will not be referred to further at this time. By a strange fatality, however, the same structure has again been subjected to the test of fire. On April 7, 1900, as was stated briefly in our issue of April 12, a fire swept through the fourth, fifth and sixth stories of the building, destroying the contents and woodwork, injuring the fireproofing, and causing the partial collapse of the roof. Compared with the first great conflagration, this last fire was insignificant, but it is particularly interesting, nevertheless, for the confirmation which it gives to some of the apparent lessons of the first fire.

For a complete floor plan and general exterior view of the Horne store building we refer our reader to the description published in our issue of May

FIG. 1.—VIEW OF FIFTH FLOOR OF HORNE STORE, PITTSBURG, PA., SHOWING DAMAGE DONE BY FIRE OF APRIL 7, 1900.

20, 1897. Briefly described, however, the building was 120×180 ft. in plan and six stories high. It is of steel skeleton construction with porous terra cotta column and floor fireproofing. In the interior a light shaft, 50 × 22 ft. in size, extends from the first floor to the ceiling of the sixth floor. This well opens into all of the floors. In addition the several floors have openings from one to the other to provide for elevators and stairways. The ceiling of the sixth floor consisted of expanded metal and plaster carried by 2 × 2-in. tees spaced 12 ins. apart and suspended from the roof framing. This framing was entirely unprotected by fireproofing. The roof itself consisted of book tile carried by 2 × 2-in. tees spaced 18 ins. apart, and had six skylights, one large one over the light shaft, one over the elevator shaft, and four other smaller ones. The two street fronts of the building contained a large number of windows glazed with ordinary plate glass and not protected against fire in any way. The windows of the rear wall were small and were protected by fireproof shutters of wood covered entirely with tin plate. The fourth wall was blank.

The fireproofing of the building as originally built was hard-burned tile, the floor arches being of the "side construction" type. When the building was rebuilt the fireproofing was changed to porous terra cotta, with floor arches of the "end construction" type. The floor system consisted of 24-ft. girders carrying 15-in. I-beam stringers, between which were sprung 15-in. porous terra cotta end construction flat arches. These arches extended 2 ins. below the bottoms of the stringers, leaving simply a hollow space 2 ins. deep to protect the lower flange. The girders which extend 7 ins. below the stringers have a flange protection of 2-in. tile and tile angle pieces covering the exposed portions of the web and tops of the flanges. The columns were protected by 3-in. tile covered with about 1½ ins. of cement.

The fire appears to have started on the fifth floor, from which it was communicated to the fourth and sixth floors, then down a dumb-waiter shaft to the basement. These four floors had all their contents practically destroyed. Pieces of burning material falling down the light shaft from the floors above also set fire to the goods and woodwork of the first floor. No damage was done to the structure to amount to anything in the basement or on the first, second and third floors. The goods on the second and third floors suffered damage from water only. On the fourth floor the contents, wood finish and flooring were consumed, the plastering was partly stripped off the tiles, and the tiles themselves in spots had lost their lower flanges, leaving the bottoms of the floor beams exposed.

A view of the fifth floor where the fire started is shown by Fig. 1. Here the woodwork and the goods, consisting of furniture, rugs, carpets, matting, etc., were practically all destroyed. The lower flanges of the tile had fallen in places, leaving the beam flanges exposed. Two columns located on opposite sides of the light well at the rear end are partially stripped of their fireproofing. At one place the end of a roof beam in falling had punched a hole about 2 ft. in diameter in one of the floor arches. The sixth floor, except where the roof had fallen in, showed about the same amount and character of damages as the fifth floor. About two-fifths of the roof at the rear end of the building fell, leaving a wreck whose general appearance is well shown by Fig. 2. It is conjectured that the flames broke through the suspended ceiling of expanded metal and plaster and the heat striking the unprotected steel roof framing caused it to collapse as shown. Outside of the fallen roof the damage to the structural steelwork was slight. The fireproof shutters at the rear windows of the burned floors were considerably damaged, but in each case they prevented the passage of the flames in any quantity.

In conclusion it may be stated that the fire protection of the building outside of the fireproofing was very poor. There was no fire hose except in the boiler room, no sprinkler system, no fire pump and no auxiliary fire alarm boxes. There were, however, fire buckets and hand-extinguishers. The neglect of such equipment furnishes its own lesson. It only remains to be pointed out that had any at all efficient fireproofing been provided for the sixth story ceiling and the roof framing above, the damage to the building structure proper would have been nominal in amount.

For the information from which this description of the fire has been prepared we are indebted to Mr. J. G. Spielman, Assoc. M. Am. Soc. C. E., of Pittsburg.

COAL STATISTICS, of the U. S. Geological Survey, for 1899, show a total production in the United States of 230,838,973 long tons. The 1898 production was 196,405,953 long tons. The total value of last year's output is estimated at $259,435,412; an increase of about 20% over that of 1898. The anthracite production was 53,837,496 long tons, valued at $88,123,493.

THE GROWTH OF THE COPPER INDUSTRY in the United States is set forth in "A Century of Copper," a German publication translated and noted by the U. S. Bureau of Statistics. This work shows that in the decade 1891-1900 the United States produced more than half the copper of the world; while in the preceding decade it produced one-third, and in 1871-80, about one-sixth of the total. In the first decade of the 19th Century the world's production of copper was only 91,000 tons; in the 5th decade it was 291,000 tons; and in the 10th decade, ending with 1900, it was 3,643,000 tons, of which North America supplied 1,963,000 tons. As showing the increasing demand for copper during the last century, the average price has only fallen from £111 per ton to £52, though the production increased six-fold. In 1899 the consumption of copper in England, France, Germany and North America, is given at 409,583 tons; as compared with 268,447 tons in 1893. In 1899 the export of copper from the United States was only 20,237,409 lbs., while in 1899 this export amounted to 254,987,164 lbs.; and the total value of copper exported, exclusive of ores, increased in the same time from $2,349,392 to $35,983,529.

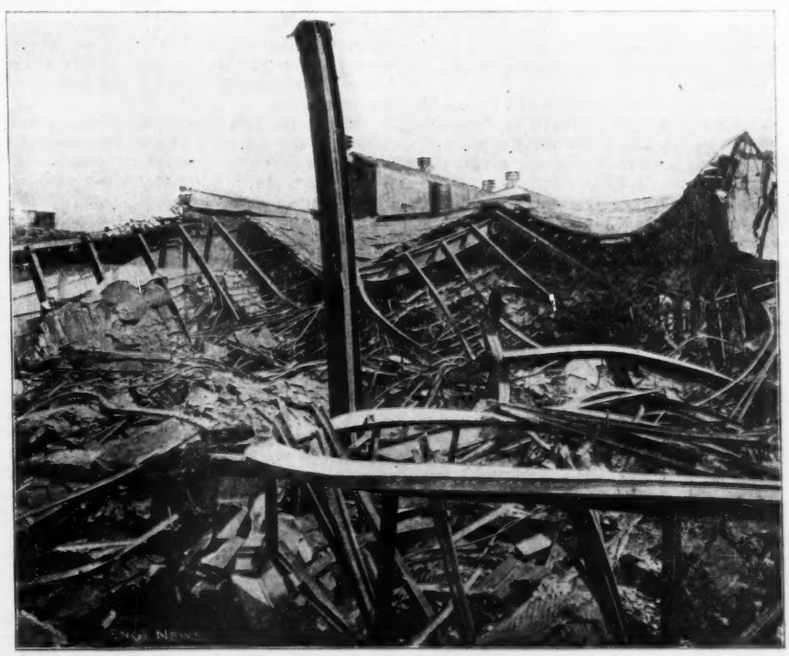


FIG. 2.—VIEW SHOWING PARTIAL WRECK OF ROOF OF HORNE STORE BY FIRE OF APRIL 7, 1900.

THE AUXILIARY HYDRAULIC PUMPING PLANT OF THE PEORIA WATER-WORKS CO., PEORIA, ILL.

By Dabney H. Maury, Jr.,* M. Am. Soc. C. E.

The main steam pumping plant of the Peoria Water-Works Co. consists of three vertical compound duplex high duty Worthington pumping engines of 7,200,000 gallons capacity each, pumping water against an average head of 300 ft., and having a rated duty of 100,000,000 ft. lbs. per 1,000 lbs. steam. Six Heine boilers of 200-HP. each furnish steam at 115 lbs. pressure to the main engines and to the necessary feed pumps, air pumps, jacket pumps, electric light engine, and other auxiliaries.†

The main well is 53 ft. deep by 34 ft. inside diameter, and formerly supplied all the water required. When, however, excessive waste and the natural increase in consumption were combined with unusual drought, this well was not equal to the demands upon it, and in 1895 a supplemental plant, drawing water from additional wells, was built. A description of this supplemental plant was published in Engineering News of Jan. 13, 1898.

In any period of low water, as is well known by every pumping engineer, the actual scarcity of the fluid itself is by no means always the greatest of the woes of the man in charge of the pumping station. As the water falls away, the suction lift of the pump increases; the pump jumps or lunges at the beginning of each stroke, and the shock of the sudden stoppage of the moving parts jars the building, and strains the machinery severely, often to the point of serious rupture. In order to reduce the violence of these shocks and also utilize the full supply of the wells, the pump must generally be run for the entire 24 hours at speed much lower than its normal, thus reducing its steam economy, and oftentimes increasing the pay roll.

All these difficulties had been experienced by the Peoria Water-Works Co., and on a large scale, prior to the installation of the supplemental plant, which continues to work very satisfactorily and which enabled the company to meet the growing demands on its supply.

Plans for the auxiliary pumping plant, now to be described, were drawn in 1895. On account of high water, the plant was not completed till 1899.

It was installed in the bottom of the main well itself, in order, principally, to shorten the suction lift of the main pumping engines, at the same time still further increasing the water supply. To accomplish these ends, a steel tank was built around the suction pipes of the main pumping engines and the suction pipes were shortened so that they should draw from the tank; four caissons, fitted with strainers, were sunk through the gravel to hardpan, to serve as additional and deeper wells; a vertical centrifugal pump was set in each of the caissons, and a Pelton water motor was set over, and on the same vertical shaft with each centrifugal pump.

The motors are driven by water at from 125 to 130 lbs. pressure from the force main of the steam pumping engines; the centrifugal pumps, directly connected to the motors, lift water from the caissons and deliver it into the tank which now supplies the pumping engines; while the water used to drive the motors is discharged by gravity into the same tank.

No water is lost, and the power required to operate the auxiliary plant is limited to that required to pump, with the high duty engines, the water which passes through the nozzles of the water motors.

The general principle is the same as that employed in the operation of the supplemental plant previously described, and both plants are covered broadly by U. S. patent to the writer.

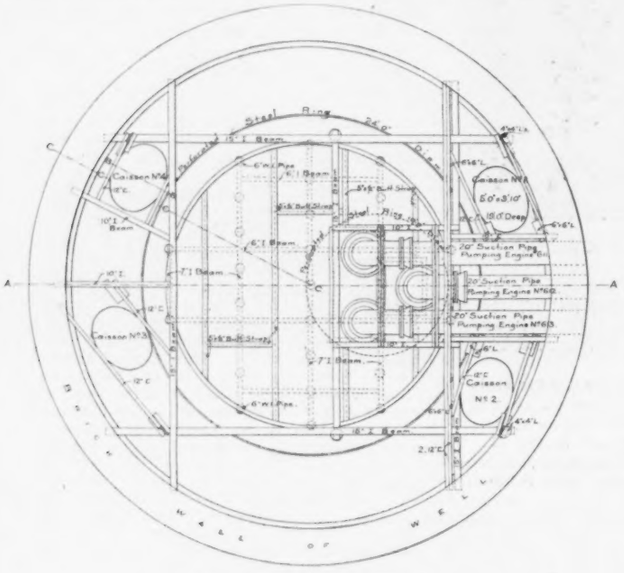

Steel Ring
24'-0"
Caisson No 4
Caisson No 3
Caisson No 2
20" Suction Pipe Pumping Engine No 4
20" Suction Pipe Pumping Engine No 5
20" Suction Pipe Pumping Engine No 6
WALL OF WELL

Fig. 1.—Horizontal Section.

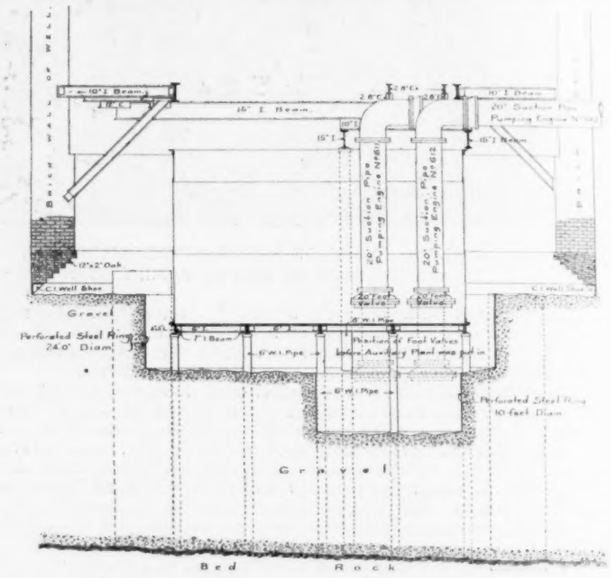


Fig. 2.—Vertical Section A—A.

FIGS. 1 AND 2.—SECTIONS THROUGH MAIN SUPPLY, PEORIA WATER-WORKS, SHOWING AUXILIARY PUMPING PLANT.
Dabney H. Maury, Jr., M. Am. Soc. C. E., Designing and Constructing Engineer.

Fig. 1 is a plan of the lower portion of the main well, showing the location of the four caissons, and the construction and arrangement of the tank; of the suction pipes of main engines with the steel frames from which they are hung; and of the beams and channels put in to carry the weight of the four units comprising the auxiliary pumping plant. Fig. 2 is a vertical section through the same part of the wall, on the line A A.

Fig. 3 is a plan of one of the units, No. 4, showing a top view of the motor with its supporting beams; Fig. 4 is a partial vertical section through the well on the lines C C, C C, and a vertical section on the line B B through caisson No. 4, showing the frame carrying motor, pump, line shafting, supply pipes, suction pipes, and discharge pipes. Fig. 5 is a horizontal section through caisson No. 4, on the line D D.

The Tank.

To secure a foundation for the tank, 30 6-in. wrought-iron pipes were sunk to bedrock through the gravel with the usual well driving apparatus. These pipes were then pumped out, filled with well-rammed concrete, and capped. To the caps were bolted the framework of 7-in. and 6-in. I-beams on which the bottom of the tank rests.

The steel tank is 20 ft. in diameter by 12 ft. deep, the vertical shell being of ¼-in. metal, while the bottom is ½-in. thick.

There are four 12-in. valves in the bottom, by which water may be admitted freely from the outside so that the main engines may draw from the tank at times of high water without running the auxiliary pumps. To keep the tank from floating up from its foundations, there is also a 10-in. check valve to admit water in case the water outside of the tank should rise above that inside, while the 12-in. valves are closed. None of these valves are shown on the drawings.

A copper float, 14 ins. in diameter by 18 ins. long, is connected by wire to a target on a gage board in the engine room, which indicates the level of the water in the tank at all times. Connected to the target is an electric alarm which rings a bell whenever the water in the tank gets too high or too low. To prevent the possibility of damage to the main engines should the water level, in spite of the above precautions, fall dangerously low, a simple and ingenious device suggested by Mr. E. H. Foster, of the H. R. Worthington Co., was installed. This device has no moving parts, requires no attention, and cannot get out of order; but when the water falls to within about 2 ft. of the bottom of the tank, the main pumping engine is gradually but surely brought to a stop. These devices are not shown on the drawings.

Caissons.

These are four in number, each being 19 ft. long and oval in cross-section, 5 ft. × 3 ft. 10 ins. The oval section was chosen because there was not room between the 24-ft. steel ring and the wall of the well to put in a circular caisson large enough for the centrifugal pump. The somewhat unsymmetrical location of the four caissons, as seen in plan, Fig. 1, is due to the fact that there were, when the caissons were sunk, a number of heavy timbers, serving as braces and supports for the suction pipes, and as these had to remain until most of the work was finished, the caissons had to be located where they would not interfere with them. All these timbers have since been removed, and the suction pipes are hung from the pairs of 8-in. channels shown above the pipes in Figs. 1 and 2.

All of the joints in the caissons are single cover butt joints, with butt straps on the inside, and rivets countersunk on the outside, to diminish friction in sinking. The bottom sheet of each

*Engineer and Superintendent Peoria Water-Works Co., Peoria, Ill.

†For an account of a duty trial of this steam plant, see a paper presented by the writer at the Springfield meeting of the Illinois Society of Engineers and Surveyors, January, 1897.

caisson is beveled to a cutting edge on the outside, and the lower section is perforated with 70 ¾-in. per sq. ft. holes, the strainers being bolted inside the caisson opposite the perforated portion.

The caissons were furnished and sunk by contract by the Shaller & Schniglau Co., of Chicago, who were the lowest bidders, and whose work was well done. The greatest error in alinement of any caisson was ⅞-in. in 19 ft. The pneumatic process was employed, the same air lock being used in turn for each caisson. In order to make the perforated lower section air and water tight while sinking, and enable the men to stand on the bottom and work, a temporary inner cylinder of steel plates was bolted to the 6×4-in. angle-ring. This cylinder covered the strainers and extended nearly down to the bottom of the caisson. After a caisson had been sunk, the cylinder was removed, and used, with the air lock, on the next caisson.

Steel Frames.

There are four steel frames, each of which carries a 24-in. Pelton water motor with supply and discharge pipes; a centrifugal pump, with suction and discharge pipes, and the vertical shaft connecting the motor and pump. Each frame is made up of two vertical 10-in. channels, connected by horizontal 8-in. channels, and braced by diagonal 2½×2½-in. L's, and, at top and bottom, by ½-in. gusset plates.

Riveted to the outside of the 10-in. channels at the upper end are vertical gusset plates, to which are riveted, on the inside, the 6×6-in. angles carrying the motor case, and on the outside, the 6×6-in. angles designed to rest upon a frame work of steel channels and I-beams built into the wall of the well, and to thus sustain the frame with its load. A pair of clevises fastened to the outer angles, facilitates the handling of the frame by a 5-ton hand-power traveling crane, which is not shown in any of the drawings, but which was installed for the purpose, on tracks running across near the top of the brick wall of the well. Extending 1 ft. below the bottom of each 10-in. channel is a steel pin tapering from 1½ ins. down to ¾-in. in diameter. In each side of the 6-in. leg of the 6 × 4-in. horizontal angle-ring in the caisson is a 1⅝-in. hole. These holes are designed to receive the tapered pins on the frame.

The frame was first brought through the door of the well house with the aid of the crane, and was then temporarily blocked up above the water until the motor and pump and pipes and shafting were permanently fastened to it. The frame with its load was then lowered by the crane till the pins touched the angle-ring in the caisson. The pins were next inserted into the 1⅝-in. holes in the angle-ring with the aid of an electric light hanging from insulated wires and burning under water. After the pins had entered the holes, the frame was further lowered till the 6×6-in. outside angles at its upper end came to rest upon the 12-in. horizontal channels provided for their support. The frame was then carefully plumbed, and the angles were bolted to the channels, to hold its upper end in position, the same office being performed for the lower end by the pins in the holes in the angle ring of the caissons. After the frame was in place, the discharge pipe of the centrifugal pump was connected to a 10-in. saddle flange on the side of the tank, while the pipes furnishing water to the motor nozzles were connected to the 6-in. supply pipe leading from the force main of the steam pumping engines. This supply pipe is not shown in Figs. 1 and 2, but a part of it may be seen in Figs. 3 and 4.

The arrangement just described renders easy any future repairs to that portion of the machinery which may be under water; for by uncoupling two pipe connections, and taking out the two bolts that hold the upper angles to their resting place in the 12-in. channels, the entire plant is free, and can be raised above water and moved to any desired position by the traveling crane. Fig. 6 is a photograph of Unit No. 4, hanging from the crane, and ready to be lowered to its working position.

Water Motors.

The simplicity and efficiency of wheels of the Pelton type, and the fact that the high pressure available was favorable to their use, made it desirable to use a motor of this class. To avoid intermediate gearing, it was necessary to put the motor on the same vertical shaft as the pump, and as there were no vertical shaft water-wheels made, the writer purchased the wheels of the Pelton Water-Wheel Co., and designed and built the covers. Many experiments were made with covers of different shapes, in which glass windows or tops were set to observe the motion of the water before and after it struck the buckets of the wheel. The cover shown in Figs. 3 and 4 was finally adopted. This is simply a roomy cast-iron box, circular in plan, with a flat bottom, having the discharge funnel at one side of the shaft and with a cover made in two semicircular lids, which can be lifted off to get at the wheel or nozzles. The cover is fitted with two nozzles and is so designed that four may be attached if desired, but as a rule not more than one nozzle is in actual use at a time. Each nozzle has a separate 3-in. valve. Provision is made for the adjustment of nozzles, so that the jet strikes the wheel at the proper distance from the shaft and at the proper elevation. Bolted to the top of the cover, there is a circular flange or ring which is cast in one piece with a strong bow frame. This bow frame carries the top vertical shaft bearing and also the upper and lower thrust bearings, to receive any vertical thrust that may not be taken care of by the hydraulic balancing device on the pump. There is a special device for the automatic lubrication of these bearings, details of which are not shown in the drawings, but which has proven very satisfactory. The other vertical shaft bearings are also of special design, and these do not require oil or grease, running cool either above or under water.

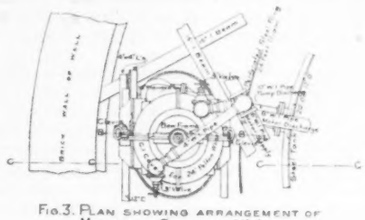


Fig. 3. Plan showing arrangement of Motor in Caisson N° 4.

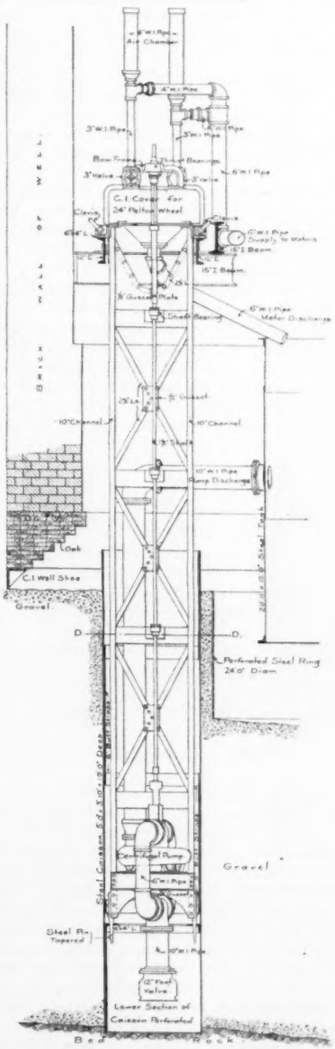


Fig. 4. Vert. Section through Caisson N°4 on line B-B ▾ Partial Vert. Section thro' Well ▾ Tank on line C-C, C-C.

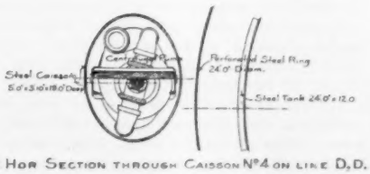


Fig. 5. Hor. Section through Caisson N°4 on line D,D.

Figs. 3, 4 and 5.—Details of Caisson No. 4 and Auxiliary Pumping Plant.

Centrifugal Pumps.

The centrifugal pumps all have 8-in. discharge pipes and polished brass runners or impellers. The specifications called for a capacity of not less than 2,000,000 gallons of water each in 24 hours, when running at 600 revs. per min. against a total head, including friction in suction and discharge pipes, of 25 ft. Bidders were allowed such latitude in the design of the pump as would enable them to employ, as a rule, most of their stock patterns, and were permitted to use any one of several types of hydraulic balancing devices for sustaining the weight of pump, shafting and motor. Each bidder was required to send drawings showing clearly the design and dimensions of his pump, and, as it was necessary to lower the pump and its pipes into the caissons, the pump was to be of such size that it could, after the suction and discharge pipes were attached, pass freely through an ellipse 4 ft. 7 ins. × 3 ft. 4 ins.

With the understanding that four pumps in all would be required, each bidder was to name his price for a first pump, which should conform to the writer's specifications and to the plans accompanying the bid; and also for two or three similar additional pumps. One pump was to be purchased outright from each of one or two bidders, the pump or pumps being chosen which seemed, before testing, to be best at the price. After careful test, the contract for the remaining two or three pumps was to be awarded to the bidder whose pump had been proven to be the best for the money.

Several pump makers submitted bids, and from these two pumps, hereinafter known as Pumps No. 1 and No. 2, were chosen, and were purchased outright from their respective makers.

A large number of tests were made at various speeds and lifts. Both pumps fulfilled the requirements as to capacity, Pump No. 2 exceeding the specified capacity by at least 30%; and while each of them was well designed and built, and showed good efficiency, Pump No. 1 excelled so much in efficiency that, notwithstanding its greater cost, the contract for the remaining two pumps was awarded to its builders.

When the successful firm was notified of the award, its manager asked permission to make certain changes in the runners or impellers of the third and fourth pumps, which he felt sure would increase both their efficiency and capacity, and offered, should the changes not accomplish what he said, to replace the impellers at the firm's own cost by others similar to that in Pump No. 1. Having confidence in this gentleman's judgment, the writer, on being informed of the nature of the contemplated changes, accepted this proposal; and, while there has been no opportunity for an exact comparison between Pump No. 1 and Pumps Nos. 3 and 4, it is the opinion of the writer, as well as of the engineers at the pumping station, that the later pumps will lift more water with the same applied horse-power than Pump No. 1.

Tests and Operation.

Tests of the Pelton water-wheels gave a maximum efficiency of 81%, at 590 revs. per min. Tests of Pump No. 1 showed a maximum efficiency of 69.6%. The maximum efficiency of Pump No. 2 was 60.3%. The friction in the vertical line shaft varied from 0.45 HP. at 506 revs. per min. to 0.66 HP. at 724 revs. The maximum combined efficiency of the Pelton wheel, line shaft and centrifugal pump, not including frictions in suction and discharge pipes, was, for the unit in Caisson No. 1, with Pump No. 1, 52.6%, and for the unit in Caisson No. 2, with Pump No. 2, 47.1%. The writer is convinced that the efficiency of Units Nos. 3 and 4, with the improved pumps, is higher than that of either No. 1 or No. 2.

With a combined efficiency of 50% for the auxiliary plant, and a duty for the main steam pumping engines of 100,000,000 ft. lbs. per 1,000 lbs. of steam, the net duty of the auxiliary plant would be 50,000,000 ft. lbs. per 1,000 lbs. of steam, a figure two or three times better than the best

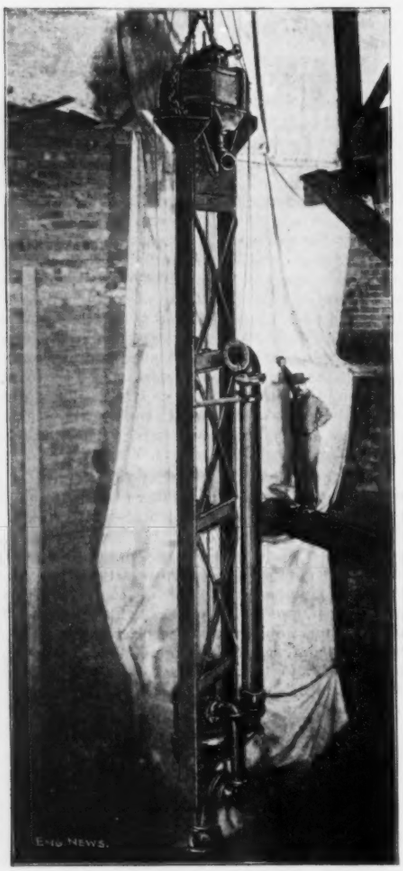


Fig. 6.—View of Frame, Motor and Pump No. 4, Suspended from Traveling Crane.

reported performance of the air-lift, and one that could not be equaled by any commercial steam pump of the same horse-power.

At this writing (January, 1900), Units No. 1 and No. 2 have been in operation about four months; No. 3 about 3 months; while No. 4, except for a successful trial spin of a few days' duration just after its completion, has not been since required, and has therefore been idle. There has been no shut down of any unit for repairs to the machinery. When once the nozzle valve is opened, the motor and pump run alone until they are no longer needed, and require absolutely no care save the filling, once in three days, of the oil reservoir on the top of the bow frame above the motor.

During the past summer, before the completion of this plant, two of the main steam pumping engines had to be run 24 hours a day at about one-third their rated speed, with reduced coal economy and extra cost for attendance, and at great risk of injury to the engines. After the completion of the auxiliary plant, notwithstanding the fact that the well had fallen still lower, one pump did the work, running smoothly from 18 to 20 hours, at nearly its normal speed, and with a suction lift not exceeding from 9 to 15 ft.

The centrifugal pumps have been delivering into the tank from 5 to 7½ gallons of water, according to the head against which they were working, for every one gallon used by the motors—the one gallon also, as explained previously, being returned by gravity to the tank.

While the writer has no accurate data on which to base the statement, it is his opinion that if the duty of the main steam plant, when one pump is running at about its normal speed, and with suction lift of from 9 to 15 ft., is 90,000,000 ft. lbs. per 1,000 lbs. of steam, then the duty of the same plant with two pumps running at not more than one-third their normal speed, and with suction lift so great as to seriously endanger, and sometimes even break, the pumps, would not exceed 60,000,000 ft. lbs. per 1,000 lbs. of steam. Granting, for the sake of comparison, that the above statement is correct, let us assume that at time of low water the duty of the main engines, when the auxiliary plant is not running, is 60,000,000 ft. lbs. per 1,000 lbs. of steam, and that they pump 5,000,000 gallons in 24 hours against a head of 310 ft.

Then the work done by the main engines in 24 hours would be $(5{,}000{,}000 \times 8.34 \times 310) = 12{,}927{,}000{,}000$ ft lbs., which at 60,000,000 ft. lbs. per 1,000 lbs. of steam would require 215,450 lbs. of steam per 24 hours.

Let us next assume that one of the main engines is running in connection with the auxiliary plant, at a duty of 90,000,000 ft. lbs. per 1,000 lbs. of steam; that the efficiency of the auxiliary plant is 50%, not including frictions in suction and discharge pipes, and that its lift is 25 ft., including the head due to those frictions. The lift of the main engines will be reduced to not more than 300 ft. The head at the nozzles will also be about 300 ft.

Then one gallon of water at 300 ft. will lift

$$\frac{300 \times 0.50}{25} = 6 \text{ gallons of water, 25 ft., into the}$$

tank. But the main engine will have to pump one additional gallon for every six gallons consumed. Therefore it will have to pump

$$5{,}000{,}000 \times \frac{5{,}000{,}000}{6} = 5{,}833{,}333 \text{ gallons;}$$

and its daily work will be

$$5{,}833{,}333 \times 8.34 \times 300 = 14{,}595{,}000{,}000 \text{ ft. lbs.}$$

This work, at a duty of 90,000,000 ft. lbs. per 1,000 lbs. of steam would require but 163,250 lbs. of steam.

In other words, other things being equal, it is cheaper during low water to run the auxiliary plant, pumping one-sixth more water with the main engines to supply it with power, than it is to run the main engines alone; the relative weights of steam required being 215,450 lbs. per day for the main plant working alone and supplying 5,000,000 gallons to the city, as against only 163,250 lbs. per day for the main plant assisted by the auxiliaries. The coal consumption may or may not be affected in exactly the ratio of the steam consumption, owing to possible differences in hours of pumping, and other minor details; but that the above comparison is not very far wrong has been shown by the fact that at the Peoria plant it is always necessary, whenever two main engines are in use at from one-quarter to one-third normal speed during low water, to use three boilers to run them; while with one engine running at full speed, alone or in conjunction with the auxiliary plant, two boilers supply all the steam required.

But the saving in steam, or in coal, is small compared with the savings in labor and in repairs, while from the superintendent's standpoint neither is to be compared to the freedom from the constant anxiety that goes with the knowledge that good and expensive machinery is being worked under conditions that may at any time result in its wreck, and perhaps in the loss of the lives of some of those who are trying faithfully to make it do more than it was ever designed to accomplish.

PROGRESS ON THE NEW WATER-WORKS FOR CINCINNATI, O.

(With two-page plate.)

In our issue of Dec. 8, 1898, we reviewed the progress of the works being carried out under the direction of Mr. G. Bouscaren, M. Am. Soc. C. E., Chief Engineer, for a new purified water supply for Cincinnati. Our description was based largely on notes taken on the spot by a member of our editorial staff. In November, 1899, another visit was made to the works and further notes taken, which have been very fully supplemented by memoranda and material for illustrations sent to us on Feb. 27 and March 30, 1900, by Mr. Alfred Petry, M. Am. Soc. C. E., Resident Engineer of the work.

The new works are designed to pump water from the Ohio River at California, O., to settling basins from which it will flow by gravity to filters and a clear water reservoir, and thence to a pumping station in the city, all as explained in our issue of Dec. 8, 1898. The intake, being located very near to the Kentucky shore, necessitated an intake pier in the river, from which a tunnel 7 ft. in diameter and 1,425 ft. long extends to the pumping station on the Ohio shore. As the range of water level in the river is about 70 ft., it was necessary to place the pumps in a deep pit, supported on a caisson having a central shaft connected with the tunnel. The caisson is of timber, 127 ft. in diameter and 20 ft. high, resting on a steel shoe. It supports the side walls of the pump-pit and pumping station.

The view, Fig. 1, shows the caisson in the process of being sunk. The floor is the deck of the caisson; the outer steel shell, or diaphragm, has been carried up two courses, ready to be enclosed in the masonry wall (see Fig. 2); the central shaft is ready, or about ready, for the air lock (Fig. 3); the extracting and boom derricks are partially ready; and one of the four hoisting engines and the steam boiler for supplying them can be seen. The 12 × 12-in. timbers against the openings in the base of the central shaft are pressing sheet lead against the flanges in order to close the openings temporarily.

Fig. 2 shows the heavy timber sheathing on the outside of the caisson, the first course of masonry and the steel diaphragm under construction. It will be noticed that the masonry is quite heavy and of good quality.

Progress on the pump-pit to Feb. 27 and some details of the methods employed are given by Mr Petry, as follows:

> The pump-pit is practically completed, the caisson being in its definitive position and back-filled and the masonry wall being finished, except pointing, which the cold weather forbade. The total depth which the caisson was sunk was 67.8 ft., of which 17 ft. was through clay loam and the rest through sand and gravel. The central 10-ft. shaft had an air lock fitted to it, with two compartments, one for men and the other for extracting purposes. Only the man lock was used in sinking the caisson, the other being used since that time for tunnel and shaft work. There were twelve other shafts in the caisson, each 3 ft. in diameter, which were used during sinking. Six locks only were used on these shafts, the others being closed with metal diaphragms through which blow-pipes were passed. The loam was all extracted with buckets; but nearly all the sand and gravel was removed by means of blow-pipes. The caisson was back-filled with sand. The pump-pit shaft has been sunk and lined with brick, and the tunnel has been excavated to a length of 600 ft.; but none of it lined, as yet. The material encountered is limestone and shale in alternate strata of varying thickness, and so far no trouble has been had in the tunnel on account of leaks. The excavation and lining of shaft were carried on under an air pressure running up to 25 lbs. in excess of the atmosphere; but no pressure has been needed in the tunnel, so far. The excavation has been made all from the pump-pit end, although preparations are now being made to begin at the other end.

The caisson for sinking the intake pier was built on the Kentucky shore and launched on tracks, as shown by Fig. 4. The framework above is for the coffer dam. The boilers, air-compressors, dynamo for lighting and concrete mixer used for this work

were placed on a barge located at the site of the pier. Fig. 5 is a view of the pier while under construction. On March 30, Mr. Petry informs us, the intake pier caisson had been sunk and back-filled with concrete, and the pier had been carried up to a height of 64.7 ft. above the top of caisson, the total height to be attained being 101 ft.; also that 1,032 ft. of the intake tunnel had been holed, but none of it lined.

The improvements include a branch line connecting the work with the Cincinnati, Georgetown & Portsmouth R. R., which has been so far completed as to permit the running of trains out from Cincinnati. The valley of Lick Run is crossed by a steel viaduct 630 ft. long on an 8° 30′ curve. A profile of the bridge is shown by Fig. 6. It will be seen that the lowest panel of the towers is below high water mark. All the members of the trestle are designed to take either tension or compression. Bronze strips are used in the sliding shoes, as shown in Fig. 8, to prevent the rust and sticking that would result otherwise when the feet of the towers are under water. The bridge can be seen in the distance in Fig. 9.

To protect a portion of the water-works property from the washing of the Little Miami River some bank protection work was carried out, as shown by Fig. 9. Mr. Petry describes this as follows:

> It consists in bringing the river bank to a uniform slope and revetting it with stone paving laid dry. The foot of the slope is protected by a training wall of piles, sheet-piling and loose stone. The eroding action of the low water stage of the Miami was so rapid that some temporary protection had to be used until the permanent protection could be completed. Anything expensive was, of course, not to be considered, so I built walls along the front, composed of fascines of horse weeds weighted down with sand bags. It cost very little and worked very well.

Besides our indebtedness to Mr. Bouscaren and Mr. Petry for information used in preparing this article we desire to acknowledge courtesies shown by Mr. Clifford N. Miller, Assistant Engineer. Messrs. Geo. H. Benzenberg and Chas. Hermany, M. Am. Soc. C. E., are consulting engineers for the new works, which are being built by a board of which Mr. Aug. Herrmann is president. The contract for the intake pier, tunnel and pump-pit was let to F. H. Kirchner & Co., Cincinnati, who sublet the pneumatic work to John Monks & Son, New York City, Mr. Daniel E. Moran, M. Am. Soc. C. E., of the latter firm, having charge of their work.

NOTES ON GARBAGE DISPOSAL AT CINCINNATI, O.

During a visit to Cincinnati, about the middle of November, 1899, a member of the editorial staff of this journal improved the opportunity to inspect the garbage reduction works of that city. The Simonin system of extracting grease by means of naphtha is employed, the garbage being exposed in the extractors in shallow pans, stacked on cars, as described in detail in our issue of Oct. 8, 1896. The plant is located on the Ohio River, just inside the city limits, and the garbage is taken to the works on scows.

The visit was made late on a Saturday afternoon, when the plant had been shut down since morning. The man in charge said that no important changes in the works had been made for a number of years. A total of 15 men are employed at the plant, including three at night.

The garbage is raked from storage chutes or pockets into the pans, which, with the reverse process of emptying the pans, requires much hand labor. It was observed that while the combined extractors and driers are in themselves quite simple, except for the stacks of pans just mentioned, quite an extensive system of piping is provided, outside the extractor house, for recovering the naphtha. The shallowness of the pans also suggested the necessity of pretty careful separation of tin cans and other foreign substances from the garbage. The pans have to be run outdoors, in their passage from the extractor to the tankage house, where the tankage is screened and bagged. The grease is barreled.

The floors of the buildings were well cleaned. There was no odor in the extractor building, and scarcely any was noticed in the tankage room, but the plant was not running. Close by the pockets for storing green garbage there was a sour garbage smell, as there is bound to be wherever garbage is stored, unless deodorants are very liberally used.

A number of inquiries among various classes of people resulted in generally favorable reports regarding the absence of odors from the plant. Going out to the works, the street car conductor on the line running by the plant said he noticed a decided odor when his car passed, in case the extractors were in use. On the return trip on the same car line another conductor said there was no odor observed except on muggy or damp mornings, but there was a very bad odor from a plant for rendering dead animals, a mile further on. A mechanic living in the vicinity, but not very near the garbage reduction works, had no complaints to make. A prominent engineer in Cincinnati, engaged in private practice, said he had heard of no complaints. Three Cincinnati business men thought the plant gave no trouble. On the whole, the writer was favorably impressed with the sanitary condition of the works, as cleaned up and shut down for Sunday, and with the general reputation it seemed to bear in the city. In nearly all garbage reduction works there is some storage before treatment, and more or less exposure at various stages of the process, notwithstanding the claims so commonly made for certain processes that immediately on reaching the plant the garbage is dumped in air-tight receptacles and never exposed to the air again until it comes out as a fertilizer or fertilizer base. At Cincinnati the garbage, once in the extractors, and the latter sealed, the material is not again exposed until the grease has been extracted and the tankage dried. The writer noticed one extractor open and ready for removing the dried garbage, the latter being quite crisp and having scarcely the slightest odor. Mr. Tucker is General Superintendent of the reduction works of the Sanitary Extracting Co.

As supplementary to the above notes, and to our original article, we have taken the following information from a paper on the "Disposition of Garbage at Cincinnati, O.," by Mr. August Herrmann, of that city, published in the report of the American Society of Municipal Improvements for 1899:

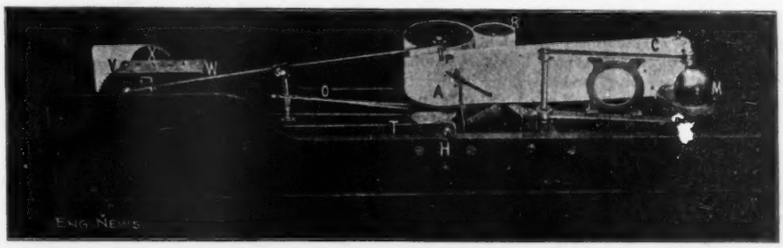
Prior to 1892 the garbage of Cincinnati was dumped on vacant land. Although the sprinkling of lime over the garbage dumps reduced the offensive odors incidental to them there were many complaints from people living or doing business in the vicinity. This led to the ten years' contract under which the garbage reduction works were built in 1892. The contract provides for the reception by the contractor, at points mutually agreed upon, of all the "vegetable and kitchen garbage that may be collected and delivered by the city at such point or points, the same to be unmixed with ashes or other refuse matter." The city agreed to prevent the dumping of garbage at other places and to collect and deliver the garbage to the contractor. The contractor agreed to build and operate a plant for the "scientific and sanitary disposition" of the garbage, "in a mode not injurious to health or comfort." He also agreed to give a bond of $25,000 for the faithful performance of his contract. Mr. Herrmann stated that up to October, 1899, no complaints had been "received from persons residing in the immediate neighborhood" of the works.

In the description of the plant in our issue of Oct. 8, 1896, it was stated, on authority of the health officer of the city, that the amount of garbage delivered by the city to the contractor in 1894 was 13,894 loads, estimated at 17,368 tons. Mr. Herrmann states that not over 15,000 tons a year are delivered to the contractor by the city, and that the amount "is constantly decreasing." This, he says, must be due to mixing the garbage with ashes and other refuse by the householder, or by the street cleaning department, the motive for the latter course being the desire to save long hauls to the garbage scows, the distance "in certain instances being many miles;" or else "the consumption of garbage for fuel for domestic purposes is constantly increasing." Such a use has been "demonstrated by a careful examination in certain districts," and "generally gives satisfaction, especially in the winter season."

Dead animals and slaughter-house offal are removed under a separate contract, made in 1893 (with the Jones Fertilizing Co.—Ed.) under a ten years' contract. The contractor neither receives anything for the work nor pays for the privilege, except as the opportunity to secure such material may be considered as a return for the service rendeerd. He is required to remove all this refuse in covered wagons, approved by the Board of Administration, taking it promptly outside the city limits. He has the right to use a city wharf without charge, and was required to give a bond of $25,000 for the satisfactory performance of the work.

THE VIAGRAPH; AN INSTRUMENT FOR RECORDING GRAPHICALLY INEQUALITIES IN ROAD SURFACES.

An instrument for obtaining a graphical record of the inequalities in road surfaces has been in use for some time in England. It is known as the viagraph, and is defined as being "in principle a straight edge applied continually to the road surface along which it may be drawn," provided with a pencil and roll of paper for recording the vertical changes of the surface in relation to the straight edge. The device, with the cover removed, is shown by the accompanying view. The main frame carries a lever, T, pivoted to it at H, and carrying on its free end a toothed wheel, V. The wheel rises and falls with the unevenness of the surface, recording the latter by means of the link and lever, S, and the pencil P (raised abnormally in the view), on the roll of paper. The profile thus given is of full size, vertically, and ⅛-in. to 1 ft., horizontally. The second pencil draws a datum line, with which that drawn by the first would coincide if the road in question were perfectly level. The sum of the vertical registration of the upper pencil is called "the numerical index of unevenness," and is also recorded automatically by the decimal counter, W. This is effected by attaching a cord to the free end of the lever, T, passing it once around the double-grooved pulley, X, and connecting it with a rubber band at O. The cord rotates the pulley in accordance with the movement of the lever, the rubber band stretching when the lever falls, and the pulley being held fast when the lever rises again, by means of another rubber-tightened cord, passing around the second groove in the pulley. Thus the pulley rotates intermittently, in one direction, and its total movement is indicated on a decimal counter.



AN INSTRUMENT FOR RECORDING GRAPHICALLY VARIATIONS IN ROAD SURFACES.

For information regarding this device we are indebted to Mr. I. Brown, Longhurst, Dunmurry, Belfast, Ireland, who, we understand, invented it.

POWER TO EXPEND $4,000,000 A YEAR in acquiring dock property in New York city is granted by a bill just signed by Mayor Van Wyck. This is said to be in addition to the $3,000,000 a year now available for improving docks already owned by the city. The bill now goes to Governor Roosevelt.

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In ordering changes of mailing addresses, state BOTH old and new addresses; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 320 means that subscription is paid to the 32d week (that is the issue of Aug. 9) of the year 1900; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents a line. Want notices, special rates, see page XXI. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.

A ballot list of candidates for election to the various grades of membership of the American Society of Mechanical Engineers has just been sent out by the Secretary, and it is, we believe, the longest list the society has ever had. It includes 70 names proposed for membership, of which 10 are for promotion from the junior grade, 19 for associate and 43 for junior membership, a total of 132. The length of this list is one indication of financial prosperity in the engineering profession.

In accordance with the usual custom of the society, the ballot list is accompanied by a "professional service sheet," giving a brief statement of the place and date of birth, of the education, and of the practical experience of each candidate. From this sheet it appears that of the 70 candidates for full membership, 18 are 40 years of age or upwards, and 52 under 40. Of the 18 older men, only three have received engineering degrees from technical schools, four have had some training in such schools, and 11 mention no technical course, but began their engineering career in the shops. Of the 52 men under 40, 27 have the degrees of M. E., C. E., and B. S., from engineering colleges, 15 have had partial courses, without obtaining degrees, and only 10 have had no technical school training. Of the 43 candidates for junior membership, 23 have degrees from engineering schools, 9 have had partial courses, and 11 shop training only.

Probably by the time the next issue of Engineering News reaches its readers, the Hepburn bill, providing for the construction by the United States of a ship canal across Nicaragua will have passed the House of Representatives. Unanimous consent to devote May 1 and 2 to the consideration of the bill was granted on April 23, and a large majority of the members are reported to favor its passage. Following its passage in the House, it will be taken up in the Senate, and its chances of passage in that body are also considered good.

An important amendment has been made to the bill since its original introduction, by which the provision for the fortification of the canal is omitted, and the chief sections of the bill now read as follows:

The President of the United States be, and is hereby, authorized to acquire from the States of Costa Rica and Nicaragua, for and in behalf of the United States, control of such portion of territory now belonging to Costa Rica and Nicaragua as may be desirable and necessary, on which to excavate, construct and protect a canal of such depth and capacity as will be sufficient for the movement of ships of the greatest tonnage and draught now in use, from a point near Greytown, on the Caribbean Sea, via Lake Nicaragua, to Brito, on the Pacific Ocean; and such sum as may be necessary to secure such control is hereby appropriated out of any money in the Treasury not otherwise appropriated.

Section 2.—That when the President has secured full control over the territory in Section 1 referred to, he shall direct the Secretary of War to excavate and construct a canal and waterway from a point on the shore of the Caribbean Sea near Greytown, by way of Lake Nicaragua, to a point near Brito, on the Pacific Ocean. Such canal shall be of sufficient capacity and depth so that it may be used by vessels of the largest tonnage and greatest depth now in use, and shall be supplied with all necessary locks and other appliances to meet the necessities of vessels passing from Greytown to Brito; and the Secretary of War shall also construct such safe and commodious harbors at the termini of said canal and such provision for defense as may be necessary for the safety and protection of said canal and harbors.

It is undoubtedly true that a general and more or less clamorous public sentiment demands the passage of a Nicaragua canal bill at the present session of Congress; but it will be a pity if the legislation for so enormous a work is forced through without the fullest consideration of what it involves. Almost every engineer has experienced the tide of public clamor which demands immediate action on contemplated works, and regards the time spent in engineering investigations as wholly wasted. A long list of disasters, financial, structural, and even political, can be traced to just this lack of thorough preparation and investigation at the launching of large enterprises.

A year ago Congress gave a million dollars to an able commission to conduct investigations and advise as to the best route for, and the political and commercial interests involved in the construction of a canal across the Central American Isthmus. That commission has now and for months past had hundreds of engineers at work making the closest investigation of the different available routes. If Congress passes the Hepburn bill it will itself select the Nicaragua route, regardless of the investigations which it has itself authorized.

Perhaps the Nicaragua route is the best, but what knowledge have members of Congress that this is the case? Is it knowledge or is it prejudice and the pressure of an equally uninformed public sentiment that leads them to decide upon it?

Again, if Congress desires to fix upon and provide for construction upon the Nicaragua route, it ought at least to do it in a business-like fashion. By the terms of the bill, control of a strip of land across Nicaragua and Costa Rica is to be purchased by the Secretary of War at any price those countries may choose to ask, short of the total surplus in the United States Treasury. Notice is practically served on the de facto governments of those turbulent republics that Uncle Sam wants to buy at any price—"Name your own figure," says he.

Still again, if an Isthmian canal is to be built, is it not wise to devote a little attention to the matter of methods, and organization instead of dumping the whole task on the War Department?

The fact is that one of the weakest features in our present system of popular government is the manner in which responsibilities are heaped on the shoulders of a public officer, without the slightest inquiry as to whether he or his department are not already overburdened with work. Turning over the Nicaragua canal construction to the War Department means turning it over to the Corps of Engineers, and that organization is already laboring under a much larger load of work than it can properly perform. The plan which experience has shown to be the best for the carrying out of such great public works is to place them in charge of an appointive commission, such a body, for example, as that which built the great Metropolitan drainage system of Massachusetts, the Sanitary Canal at Chicago, or the new water-works of Cincinnati, described in this issue.

If the House fails to consider these matters, in its headlong eagerness to pass a Nicaragua Canal bill, they may, perhaps, receive attention in the Senate. For the sake of our national reputation, too, it is to be hoped that ratification of the Hay-Pauncefote treaty may precede the final passage of the bill. To enact a law in contravention of a long-established treaty with our best friend among the nations, and at the same time to refuse to approve a new treaty making such a law possible, would be a wanton breach of international courtesy, wholly inconsistent with our position among the nations of the world.

MUNICIPAL CLEANSING IN GREAT BRITAIN.

The specialization of technical societies and of societies for municipal officials seems to have gone quite as far in England as in America. One of the newest and most promising of these English bodies is the Association of Cleansing Superintendents of Great Britain, which held its first annual meeting at Birmingham in 1898. Through the courtesy of Mr. F. W. Brookman, Secretary of the Association, we have received the latest report of the Association and a copy of an earlier paper by Mr. Brookman. Mr. Brookman is superintendent of the sanitary works of Rochdale, England. These papers contain many interesting details of English practice which we propose to review briefly, referring our readers to the reports for more complete information."

In the paper on "Street Cleansing and Watering," by Mr. J. Jackson, Superintendent of Cleansing, Sheffield, emphasis is laid on "the great importance of knowing the area of all the streets swept, in order that a proper day's work may be obtained." This principle might well be put in practice for all branches of work, there being nothing like a good system of records for judging of the efficiency of different methods of work, the faithfulness and industry of the workers and the appropriations needed in future years.

The washing of streets by means of hose streams is favored by Mr. Jackson, but he well says that "no superintendent is justified in obtaining clean streets at the expense of dirty sewers." To avoid this he sweeps the streets and carts away the sweepings before washing. All catch-basins, he says, should be trapped and the basins "emptied, if required, both previous to and immediately after the swilling (washing—Ed.) is over." Generally most of the wood paving of Sheffield is washed twice a week, "but in greasy weather it is washed three times per week, as no good results can be obtained by trusting to brushes only." Each washing gang is composed of "one trained turncock, one nozzle man and an assistant," supplemented by a horse-broom if the streets are in a greasy condition. The "trained turncock" is provided to avoid damage to the street hydrants, and it is suggested that he be a man familiar with the water pressures at various points. The street washers work from 1 to 8 a. m. Two gangs of three men can wash about 2,600 lin. yds. in one night, or 31,200 sq. yds. of street averaging 36 ft. in width. The cost of this service (for two gangs per night) is placed at $9.70 for six men and two horses, and 55 cts. for wear and tear of hose and brushes, making $10.25 in all. On this basis 200 washings per year would cost about 8 cts. per sq. yd., Mr. Jackson states. He might have added that this, combined with the cost of sweeping and carting is more than most cities would be likely to stand, except for limited areas.

What Mr. Jackson says about the employment of old men as street sweepers is so good, that we quote it in full, both for its practical value, and as an antidote for the unqualifiedly fulsome praise with which some of our American writers on municipal government have described the inner workings of English towns:

Cleaning of Courts and Back Streets.—This work should be carried out by the "aged sweepers" in the daylight. As far as possible the old men should work in gangs together, and the sweeping of courts and back streets is work for which they are fitted. If these men work in the main streets, especially in the day time, they are much more liable to injury by passing vehicles than the younger men. The old men require less supervision than younger men, and if their work is put on to a regular system they can be depended upon to carry it out on the whole satisfactorily.

*See notices under, "New Publications," elsewhere in this issue.

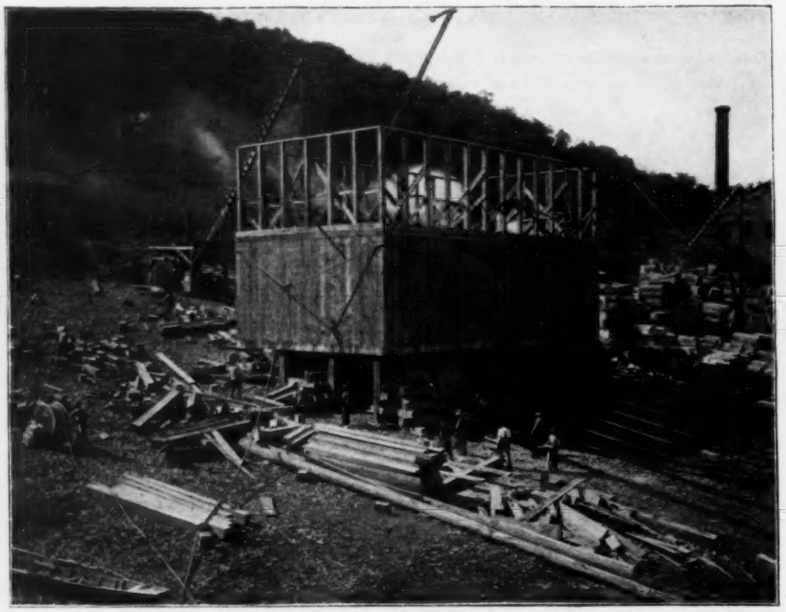


FIG. 4.—INTAKE-PIER CAISSON, WITH COFFERDAM FRAMEWORK ABOVE, READY FOR LAUNCHING.

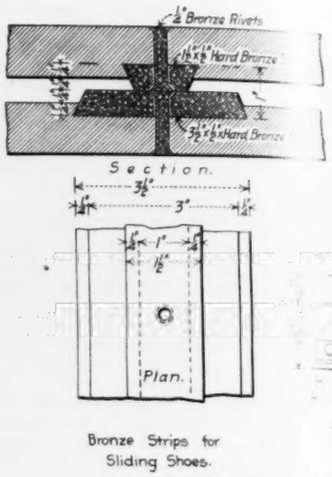


FIG. 7.—DETAILS OF SLIDING AND FIXED SHOE

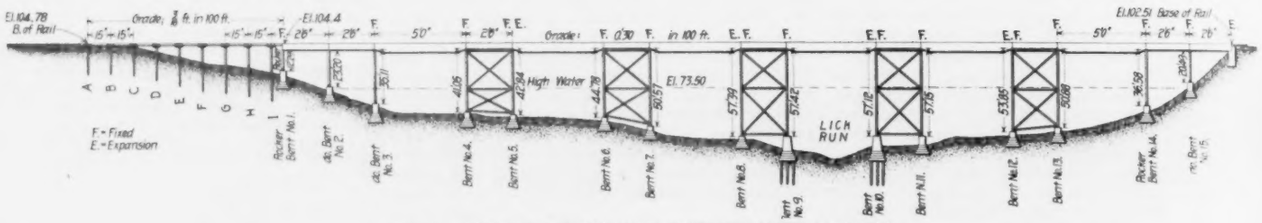


FIG. 6.—PROFILE OF RAILWAY VIADUCT OVER LICK RUN.

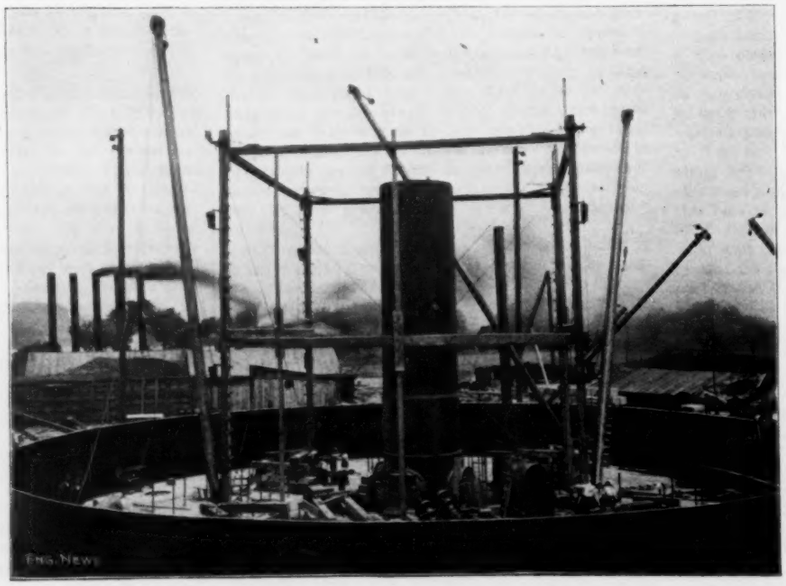
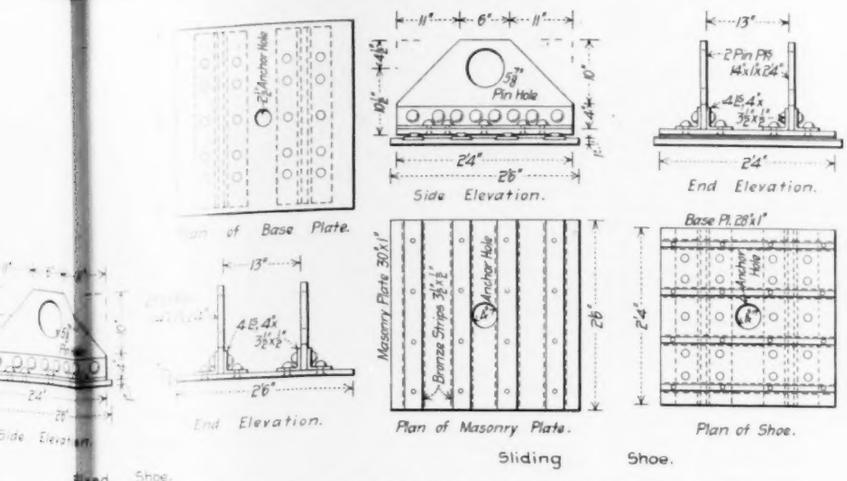


FIG. 1.—STARTING THE PUMP PIT ON TIMBER CAISSON.

FIG. 8.—BANK



SLIDING AND FIXED SHOES, WITH BRONZE STRIPS FOR TOWER BENTS OF VIADUCT.

FIG. 3.—AIR LOCK FOR CENTRAL SHAFT.

FIG. 5.—INTAKE-PIER UNDER CONSTRUCTION.

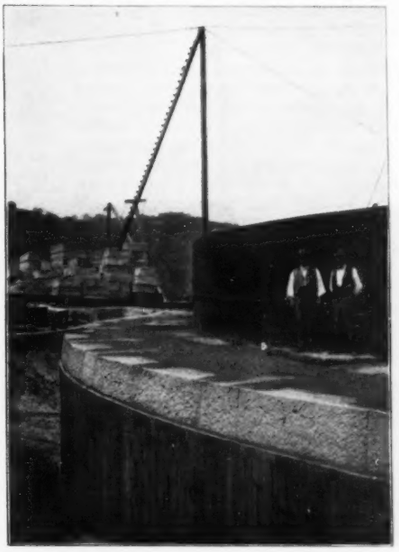


FIG. 2.—FIRST COURSE OF MASONRY AND FIRST TWO RINGS OF ENCLOSED STEEL DIAPHRAGM.

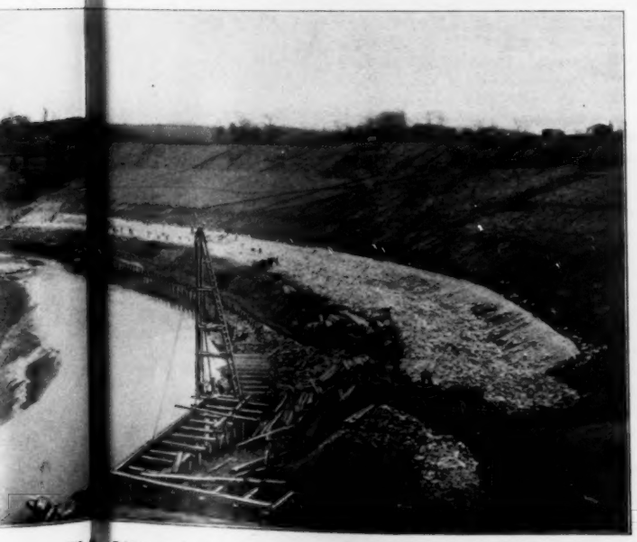


FIG. —BANK PROTECTION WORK, LITTLE MIAMI RIVER.

THE NEW WORKS
FOR THE WATER SUPPLY
OF CINCINNATI, O.

G. Bouscaren, M. Am. Soc. C. E.,
Chief Engineer.

Alfred Petry, M. Am. Soc. C. E.,
Resident Engineer.

The growing tendency in most towns is toward employing more aged men, as there is a strong impression that after a man is unable to follow any other occupation he is quite good enough for street sweeping. While sympathizing to a great extent with the good motives which lead members of the councils to recommend aged men as sweepers, the practice can be overdone. The old men are a hindrance if engaged in following the machines in main street work or in gully emptying. If working along with younger men the whole gang is spoilt, as the speed of the gang is to a large extent regulated by the slowest man.

Whilst dealing with this delicate matter I think it is my duty to say that many so-called old men are much better workers than some of the younger men. I am strongly in favor of dividing the men into grades, viz.: first class, second class and third class sweepers, so that the age question shall not be the only test of a man's capabilities.

While this quotation shows that other considerations than fitness for service sometimes obtain in Great Britain, it is noteworthy that it contains not the slightest suggestion of employing incapable men for political reasons, and that it proposes to classify workers according to ability, instead of putting them all on a dead-level, as is so commonly insisted on in this country.

At the other extreme from employing old men Mr. Jackson records that 30 boys are engaged in picking up horse droppings and filth, working from 8 a. m. to 4:30 p. m. They cover six miles of the principal streets at a cost of $3,250 a year, or about 2½ cts. per sq. yd. The boys require much watching, having a tendency to neglect their work, carry travelers' luggage, spin tops and otherwise amuse themselves.

As to watering or sprinkling streets, Mr. Jackson says that the principal streets should be sprinkled twice a day, except wood pavements, which in his "opinion should never be watered for the purpose of keeping down the dust, unless by a system of hose for watering the street channels." Washing with a hose three times a day, in the early morning hours, as already described, is considered far preferable to sprinkling wood pavements. Where such pavements are watered sand or some other material must be sprinkled over them to prevent danger to horses and cyclists from slipping. Mr. Jackson states that "all wood pavements should be well shingled (sanded) in wet weather, otherwise the surface is very slippery and dangerous." This practice prolongs the life of the wood, the sand working into it and increasing its wearing qualities. It appears from Mr. Jackson's paper, and from others in the report under consideration, that sanding streets is quite common in Great Britain. He estimates that in Sheffield about 900 short tons are required yearly for sanding streets in wet and "frosty" weather, the cost of which is about $1,300 for material and $1,200 for labor in spreading, besides which most of it must be removed when the streets are cleaned. He hopes to utilize crushed or ground clinker from the refuse destructor for this purpose in the future. This material is used at Bradford.

One of the most carefully prepared and suggestive papers was a brief one by Mr. E. Shapnell Smith, Honorable Secretary of the Liverpool Self-Propelled Traffic Association. It was entitled "The Application of Mechanical Power to Street Cleansing," by which was meant the substitution of steam, electricity or other like power for horses in drawing sweepers and wagons for collecting street dirt. Mr. Smith strongly favored such a plan and preferred steam to the other forms of motor vehicles, presenting estimates in support of his views. To increase the efficiency of steam motor vehicles by providing against idleness he suggested that manufacturers supply "a standard frame upon which can be placed a water tank, a dust-van, a slop-cart, an open platform, a sweeping machine, or any other form of superstructure that it may be expedient to use at any season of the year." One of the strongest reasons urged for the adoption of motor-vehicles by cleansing departments is that they lessen the work of the department directly, and indirectly also, as object lessons, "since they neither produce droppings nor disintegrate the materials of which the streets are made." According to Mr. Smith, Glasgow has ordered an electric dust-van, and his estimates of the economy of motor-vehicles for cleansing departments is borne out by "the experience of Chiswick, Chelsea, Leyton, Battersea, Camberwell and Liverpool." The experience of Chiswick and Liverpool with motor vehicles is given by Mr. Smith as follows:

In the case of Chiswick, where Messrs. Thornycroft's vehicles were adopted more than two years ago, the actual saving was £2,468 in two years, the cost being £4,271 and £1,783 for horse and motor dust-vans, respectively. Two motor dust-vans deal with 50 cu. yds. a day, whereas each of the horse carts used to deal with only 5 cu. yds.

In the case of Liverpool I have the authority of Mr. John A. Brodie, M. Inst. C. E., City Engineer, to state that his eight months' experience with a motor supplied by the Lancashire Steam Motor Co., Leyland, has effected an economy of over 50 per cent. So far Mr. Brodie has as far as possible confined the operations of his motor to distances of not less than two miles per journey.

That Mr. Smith's general proposition favoring the use of motor-vehicles met with the approval of his audience is shown by the following resolution, adopted at the conclusion of the reading of his paper:

That this Annual Conference of the Cleansing Superintendents of Great Britain assembled in Glasgow this 7th day of September, 1899, is of opinion that recent developments in the construction of motor vehicles justify the gradual introduction of self-propelled vehicles in several branches of cleansing operations, and this meeting recommends municipal, urban and other authorities to take the question into their serious consideration.

In striking contrast with American experience it is taken for granted in Great Britain that where city refuse is burned it shall be not only without the use of extra fuel, but that heat will be generated by the refuse and put to use in a variety of ways. Several of the papers contained the results of tests designed to show the amount of heat so utilized in various plants. Unfortunately the character of the refuse burned abroad differs so widely from ours that the results there obtained are not readily applicable to American conditions. Doubtless great advances in burning garbage and other refuse might be, and will be, made in this country through a careful study of English practice in both the construction and operation of garbage furnaces. Only 20 per cent. of the screened refuse of Glasgow is burned, the remaining 80 per cent. going to the municipal farms and to other farms in the surrounding country. This fact should be borne in mind when the practice at Glasgow is cited as an argument in favor of the mixed system of collection and disposal of garbage, ashes and other refuse in New York.

Besides utilizing heat at the English furnaces, the clinker, or residue, is turned to a variety of purposes. Some such practice is quite essential for the reduction of working expenses, since the clinker amounts to from 25 to 40 per cent. of the refuse before burning. At Bradford an average of 300 (long) tons of "ashpit refuse" is collected daily

and practically the whole of this is destroyed at our four destructors, therefore every day brings 100 tons of clinker, to be turned to profitable account if possible, if not to be carted to tips and disposed of in that manner.

This quotation is from a paper on "Some of the Means Adopted to Utilize Destructor Clinker at Bradford," by Mr. J. McTaggart, Superintendent of Cleansing in that city. In 1894, when Mr. McTaggart assumed his present official duties, he found that the greater part of the clinker at Bradford was being carted two miles and dumped, at a yearly expense of about $5,000. There were already four mortar mills in use, and in 1893 the sales of mortar had been 3,576 long tons, which brought about $6,000. The price per ton was $1.58 and $2.02, respectively, for the two grades made. By reducing the price to $1.12 and $1.58 per long ton, respectively, and by vigorous work in developing a demand for it, the annual sales have been brought up to a total of 8,070 long tons, with receipts of $10,162, or an average of $1.25 per ton. In addition nearly $1,000 was realized from the sale of crushed clinker for making concrete, and some of the finer material has been sold for use as a substitute or partial substitute for sand in making plaster. At one of the destructors machinery has been installed that crushes the clinker and separates it by screening into four grades at a cost of about 8 cents per long ton. At the time the paper was read a hydraulic slab-making plant was being erected for the manufacture of granite-faced slabs, with the crushed clinker as a base, which it was expected could be made in the proportion of 3 to 1 and sold at two-thirds the price of flagging, besides saving the cost of trimming. Brick and tile are made in Glasgow from the clinker, and Mr. McTaggart hopes to do the same at Bradford.

All this is very interesting and well worth following up by some of our wide-awake American municipalities with a view of determining whether it is most sanitary and economical to mix clean ashes and dirty garbage, haul them to and run them through furnaces, provide men and machinery to handle and utilize the vast quantities of clinker, and agents to sell the products, or to store, collect and dispose of the ashes and garbage separately, with shorter hauls and far less labor for the ashes than is required when it goes to the furnace. Most of our smaller and some of our larger American cities have not yet installed a thorough system of refuse collection and disposal. Such cities are reasonably free, when they do take up the work, to adopt such methods as they see fit, with no precedents or long-established customs to embarrass them.

We cannot properly close our review of these papers without mentioning one on "The Glasgow Corporation Farms," by E. Baillie McFarlane, one on "Boilers, with Special Reference to Destructors," by Mr. W. Bamford, and finally one on "The Utilization of Refuse," by Mr. Brookman, whose name was mentioned in our opening paragraph. The first part of the latter paper describes the manufacture of fertilizer from the material gathered by the pail system at Rochdale, England, this system still standing up these many years against all the advocates of the water carriage system. We should like to see some detailed figures of the cost of installing and operating this system of collection and disposal of excreta as compared with the estimated cost of the ordinary water carriage system, on the separate plan, and purification of the sewage by the best of the modern methods, whatever that may be. But such figures could have little more than a passing interest in this country, and we should not be surprised if even Rochdale should fail to stand out much longer against the many advantages of a water carriage system.

Of more practical value this side of the Atlantic is Mr. Brookman's description of the Rochdale refuse burning plant, the heat from which is used to operate the machinery which dries the collections from the pail system, and his general discussion of refuse burning. The Rochdale plant includes two destructor cells, each with grate surfaces 9 × 5 ft., and two 8 × 30 ft. Lancashire boilers, designed for a working pressure of 120 lbs. per square inch. The cells have a large combustion chamber, common to both, between them and the boilers. The boilers have their own furnaces, making it possible to use both refuse cells and both boilers, or a combination of one of either with both of the other. Very satisfactory results have been obtained with this plant.

LETTERS TO THE EDITOR.

Mending Steel Tapes.

Sir: Speaking of mending steel tapes, I have seen them mended in many ways, but have settled down to only one way for myself. With a punch secured from a watchmaker, at a cost of about $1, I punch in each of the broken ends two rows of holes of two or three holes each at, say, ¼ to ½-in. from the break. I vary the position of these holes to give the greatest apparent strength and according as the break is square across or diagonal. Then I take fine piano wire, or ordinary spool wire, such as can be had at any hardware store, and lace the ends of the tape together precisely as a belt is laced, except that I continue this lacing until the holes are filled up with the wire. After smoothing and pressing this lacing down with a pair of pliers, a vice, or even two blocks of wood (tapping with a hammer is likely to cause the holes to break out), I have a joint that is just about as flexible as the original tape, and will wind in any reel, and that I have never known to break at the holes.

For an emergency break I have used an ordinary half-inch rubber band and a half-round stick, 4 ins. long and as wide as the tape. Test the strength of the band by breaking it. You will be surprised and may have to try twice. Then, keeping the rubber stretched well up to its breaking strength, wrap with the ends of the tape against the flat side of the stick. Each turn of the rubber will give you about 20 lbs. pressure, and there is no danger of slipping. This joint will last from one to several days, according to the wear on the rubber. Yours very truly,

R. H. Britt.

Silver City, Idaho, April 19, 1900.

Two Definitions of Entropy.

Sir: I quote below two definitions of "entropy"—the first from the "Century Dictionary," the second from the "Standard Dictionary." It would be interesting to know whether all the scientific definitions in the "Century Dictionary" are as faulty as this one.

Entropy—(a) (In Physics) As used by Clausius, the inventor of the word, and others, that part of the energy of a system which cannot be converted into mechanical work without communication of heat to some other body, or change of volume. (b) As used by Tait and others, the available energy; that part of the energy which is not included under the entropy in sense (a).

The entropy of a system is the mechanical work it can perform without communication of heat, or alteration of its total volume, all transference of heat being performed by reversible engines. Clerk Maxwell, Heat, p. 186.

Entropy—Physics. In thermodynamics, a property of a body, expressed as a mathematical quantity which remains constant when a gas or other body changes its volume or does work without any heat entering or leaving it, but which, if a small amount of heat enters or leaves the body, is increased or diminished proportionally to this amount divided by the absolute temperature; sometimes called the thermodynamic function.

Since heat always flows from a higher to a lower temperature, a body that gains heat always gains more entropy than is lost by the body losing that heat; hence, with every flow of heat the total entropy of a system of bodies rises, and thus tends toward a maximum. Owing to a misapprehension of the meaning of Clausius, the inventor of the term, entropy has been used also to mean available energy. Very respectfully,

Cary T. Hutchinson.

71 Broadway, New York City, April 19, 1900.

(Our correspondent will remember that "even Homer sometimes nods." In our experience, we have found "the Century's" scientific definitions to be almost invariably excellent. Besides, it is fair to ask how many engineers ten years out of college, and not engaged in teaching, would be able to give any definition of entropy, good or bad.—Ed.)

Making Railway Embankments by Filling Trestles.

Sir: From a recent contribution to your columns (Eng. News, March 29, 1900), it appears that timber in embankments has contributed to fatal accidents upon more than one occasion. The sketch given there, however, does not illustrate the conditions referred to by the writer in his communication of March 20 (Eng. News, March 22, 1900).

A bed of burning coal in an embankment not filled in around trestle work would be a source of danger not falling strictly within the range of the original inquiry, but if the burning out of trestle timbers several feet below the surface involved greater risk, the gradual or rapid rotting out of the same timbers might involve some risk.

Again, if engineers still try to support too heavy embankments upon timber work along river banks, it is possible that some one of them might allow too much weight of embankment against a single or a double row of piles with cross and longitudinal bracing in the foot of a slope where there was no river bank but firm ground instead and where the piles would bear the load until they had decayed or the cross bracing had "let go."

It is natural to think at once of ideal conditions, better material, wider embankments, perfect safety; but funds are not always provided, fills cannot always be carried out 7 ft. beyond the rail nor masonry substituted for timber in every instance. The engineer must do his best under the circumstances, and one of the best things he can do is to get well into the friendship and confidence of a good roadmaster or roadmaster's foreman who has had much experience in the maintenance and perhaps alteration of new work. He will learn something of the ceaseless care and patient labor by which accidents are prevented, and it may be a little about movements of track and derailments that were never satisfactorily explained.

There is a slight defect in the sketch submitted by your Buffalo correspondent. The ties at one end rest upon the natural or undisturbed material and elsewhere upon the fill. It is safer in such cases and less expensive in the long run to have the depth of the fill nearly uniform throughout the length of the tie. The following extracts from back numbers of Engineering News should, however, be of greater interest in connection with this discussion than any comments of the writer:

Both of these quotations refer to the Bardwell's Ferry accident on the Fitchburg R. R., on April 7, 1886.

The roadbed was 31 ft. wide, 7 ft. being between the outside rail and the edge of the slope. The roadbed has not been changed since the road was built in 1864. The outer track was not moved when the second track was built.

The second track was put in use in September, 1884, and was laid by digging out on the side of the ledge. The roadbed was thus widened 12 ft., and what material came out was cast over on the outside. No indication of weakness on the outer track ever came to his knowledge. He has examined it a hundred times, and there was no weakness. The embankment was constructed entirely of rock. Herman Haupt was the contractor for the whole work, but he did not know who did that particular part. From the facts it appeared to him that the bank had gone down and left the track; what caused the bank to move he did not know. The ditches were 20 ins. deep. The water flows west in the ditch, and when there is a sufficient amount of it, it escapes through a culvert. All the water flowing there at the time of the accident could run through a 1½-in. pipe. He did not think it rained that day. It snowed a little at the time of the accident.—Eng. News, May 1, 1886, testimony of Mr. E. K. Turner, Civil Engineer.

The cause of the disaster was the slide of a part of the embankment, and the cause of this slide was the concurrence of three faults in construction. First, in 1866-68, when this portion of the road was reconstructed over the very imperfect roadbed of Messrs. Haupt & Co., a piece of cribwork was placed in the embankment, occupying considerable space midway between the track and river. This cribwork was afterward covered with earth and rock so that its presence was unknown to the present managers of the road. The contractor had forgotten it, and denied that there was any such work on the road, but after the accident the projecting ends of the timber revealed its existence, and an excavation has revealed its extent and character. The pins have rotted away, and the timber has greatly decayed.—Eng. News, June 5, 1886, quoted from Report of State Railroad Commissoner of Massachusetts.

It will be noticed from the above quotations that the second track was not placed between the first track and the river. M. Am. Soc. C. E.

New York, N. Y., April 11, 1900.

Thoughts Concerning the Austin Dam Failure.

Sir: In studying the views of the broken dam at Austin, published in your last issue, my attention was attracted to the very large amount of silt which had evidently accumulated above the dam before the break occurred. In the article,* by Prof. Taylor, in your paper several weeks before the failure occurred, it was shown that the long, narrow reservoir behind the dam had become filled with sediment for nearly half its depth. At the dam, according to the soundings made in January, 1900, the average depth of water was only 27 ft. Now, when the flood came, its natural effect would be to sweep out the sediment deposited on the upper part of the reservoir and drop

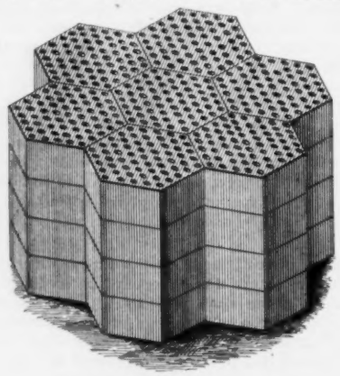


Fig. 1.

Fig. 1.—Perforated Hexagonal Powder, Devised by Gen. Thos. J. Rodman, 1857.

it at the point of largest cross-section and least current velocity, near the dam. The stranded barrel and driftwood in Fig. 5 and the banks of silt in Fig. 9 of your last issue appear to strongly confirm the idea that the back of the dam was filled in with silt pretty well toward its top when the break occurred.

Now, the question which I desire to submit for the consideration of the profession is this: What will be the pressure on the back of a dam in such a condition? Does it not become more of a retaining wall than a dam, and if the silt is sufficiently fluid may not the pressure against the dam be considerably greater than the pressure from a similar mass of water?

I do not know that this was the case at Austin; and I call attention to the matter only as something which deserves consideration in the design of dams on silt-bearing streams. As I look at the mattor, the pressure of the silt would be, as in the case of any retaining wall, that due to the wedge lying between the dam and the plane of repose of the silt. The pressure, then, would depend on the angle of repose, and some varieties of river mud spread out pretty flat when unconfined. Very likely in most cases the silt would stand well enough to lessen rather than increase the pressure on the back of the dam; but can we always be sure that this is the case, and is it not a matter to which the designer of dams should give attention?

One more point regarding dam design and I am done. The failure of the Austin dam has shown the possibility that a masonry structure may fail by sliding on its base. The overturning tendency is also a thing to be guarded against by the dam designer. Now, why not, as an additional safeguard against both these forces, anchor any such dam to its foundation by steel rods? It would have been a very simple and inexpensive matter in the construction of the Austin dam to have drilled some holes for 15 ft. or so down into the bedrock, inserted iron rods of double that length, filled in grout around them and built them into the body of the dam. Drilling the holes for these rods would also cause the detection of any dangerous cavities or fissures in the foundation rock and would give the engineer in charge some accurate knowledge of the character of the material which is to support the weight of the finished structure. Very truly,

M. Am. Soc. M. E.

New York, April 23, 1900.

Sir: While it seems almost too early to discuss the cause of failure of the Austin dam, for the reason that a considerable period may yet pass before it will be possible to thoroughly examine the foundation, yet the character of the failure is such as to naturally cause one to inquire whether engineering science, as applied to dam building, has provided for or taken into consideration all of the conditions necessary to insure stability.

The writer is strongly of the opinion that the whole 500 ft. that apparently moved bodily down stream slid either on the base of the dam or on some horizontal joint near the base of the dam. If this be found upon examination hereafter to have been what actually occurred, it seems entirely unnecessary to discuss the question of the strength and integrity of the foundations—that is, the character of the material upon which the dam was built. Minor imperfections in the limestone rock or in the manner in which the dam was placed upon this foundation would not account for the moving bodily of 500 ft. of the dam down stream had the dam, as originally constructed, a factor of safety equal to that advocated by engineers generally in the designing of such structures; for had the dam been so constructed as to be able to resist twice the maximum stress to which it might be subjected during floods, any failure of a portion of the foundation would doubtless have resulted in a break but little larger than that portion undermined by such imperfection.

This matter was discussed informally at a meeting of the Engineers' Club of Philadelphia on Saturday evening, April 21, at which meeting the writer presented lantern slides showing some of the views which have appeared in the Engineering News, together with some others obtained

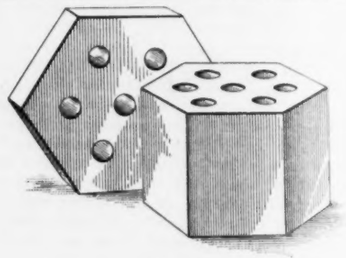


Fig. 2.

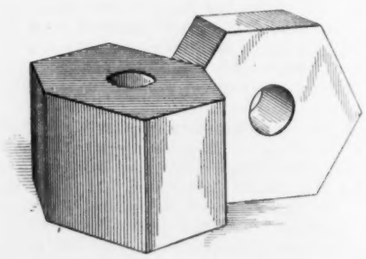


Fig. 3.

Figs. 2 and 3.—Later Forms of Perforated Powder Devised by Gen. Rodman.

later. Attention was especially directed by some of the members to the pressure which might have been exerted upon the dam by the filling in of mud and sand resting against its up-stream face, which converted the dam into a retaining wall, adding the increased pressure or thrust due to the mass of material pressing against it.

In addition to this increased stress it occurs to me that the partial vacuum created by the passage of such a large volume of water over it might add a considerable portion of the 15 lbs. atmospheric pressure to the thrust, as this partial vacuum would be formed along the down-stream face of the dam.

Again, during such a flood the back water—that is, the level of the stream below the dam—rose to a height of perhaps 30 ft. above the toe of the dam. This must have the effect of immersing the lower half of the dam, thus decreasing the weight of each cubic foot of material so immersed by 62½ lbs. and reducing very materially the stability of the structure.

So far as the general design of this dam is concerned, the facts seem to be that the engineers connected with it in various capacities at different times, both before and

*Eng. News, Feb. 22, p. 135.

during its construction, were guided by and followed current engineering practice. If this be true, no shadow of blame can fall upon any of them by reason of this failure, the responsibility for which rests with the profession.

The occurrence is certainly one justifying the most careful examination and consideration by all engineers, for if our current practice is at fault it seems essential that it be revised at the earliest possible date.

It seems to me especially desirable that the suggestions referred to—namely, the increased stresses due to partial

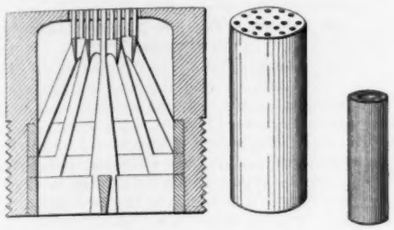


Fig. 4.

Fig. 4.—Die and Multi-Perforated Cylinder of Smokeless Powder.
(From U. S. Patent, 538,618, Issued to Hudson Maxim.)

vacuums, those possibly occasioned by a filling in of sediment above the dam and the decreased weight of the dam structure upon its foundation due to the immersion caused by back water during floods—should be discussed freely by engineers especially engaged in hydraulic engineering, and I believe your journal would be serving a most valuable purpose in calling generally upon members of the profession for an expression of opinion upon these matters, as to modifications of formulas which may be suggested to fully provide for conditions in which these factors might become an element of danger.

H. M. Chance, Consulting Mining Engineer.
Drexel Building, Philadelphia, Pa., April 23, 1900.

The Progressive Combustion of Gunpowder and the Credit for its Development.

Sir: The United States Government has, for both branches of the service, definitely adopted the multi-perforated cylinder as a smokeless powder grain for cannon. This powder is essentially an American invention. The story of smokeless powder cannot be told without mention of the high state of development to which black gunpowder had reached prior to the advent of the smokeless article.

When gunpowder was first made, it was in the form of a powder, as its name implies. At first, it consisted of a simple mixture of pulverized saltpeter, sulphur and charcoal. There was no attempt at granulation. When a gun loaded with this powder was fired, the whole charge went off with a flash, and was completely burned before the projectile got fairly started. The result was that the projectile owed its acceleration and velocity entirely to the expansion of the powder gases, and the velocities attainable with permissible pressures were very low.

With a view to slowing the combustion of the powder charge the first step was to compress the powder dust into cakes, which were broken into irregular grains or fragments. The idea of making powder in cakes and then breaking the cakes into grains, probably originated from the mixture of bitumen with gunpowder or from moistening and ramming hard to slow its combustion and better adapt the material for use in rockets. We have, however, no account of the methodical granulation of gunpowder until 1525 in France.

The next step was to increase the density and hardness of the grains and to tumble them with plumbago, which process served to free them of dust, smooth the sharp corners and impart a polish. No other marked improvement was made until the late Gen. Thos. J. Rodman, of the United States Army, took up the subject in the early fifties.

With carefully selected ingredients, prepared in a special manner, Rodman molded each grain separately under great hydraulic pressure. He was the inventor of what is known as prismatic powder. He made his grains hexagonal in form, in order to pack them more closely together, and by saving space get larger charges into the powder chamber of the gun.

Rodman succeeded in making his hexagonal grains so dense and hard that if their thickness was a little too great they did not all burn before the projectile left the

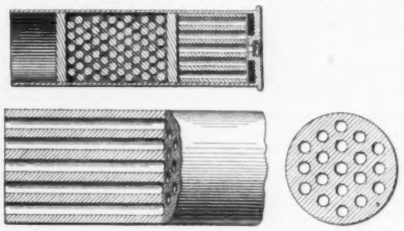


Fig. 5.

FIG. 5.—MULTI-PERFORATED POWDER AND CARTRIDGE OF WIARD.
(From U. S. Patent, 273,209, 1883.)

gun, partially burned grains being thrown out with each discharge.

It then occurred to General Rodman that if he perforated each grain with a large number of small holes presenting just thickness enough between them to permit of being burned through during the time the projectile was in the gun, he would be able to make his grains much larger, which was an obvious advantage by his method of molding each grain independently: while he would at the same time secure a result which he foresaw was still more important, namely, that of "accelerating combustion," so-called by him, and now often termed "progressive combustion."

Fig. 1 illustrates an accelerating powder charge, built up of multi-perforated grains made by General Rodman in 1857. This illustration is taken from his book entitled "Experiments on Metals for Cannon and Cannon Powder," published in 1861.

Black powder, however, did not have the tensile strength necessary to enable the advantages at first expected by Gen. Rodman to be derived from the form shown in Fig. 1. He therefore next made the form of grain shown in Fig. 2, and finally abandoned that for the grain with a single perforation shown in Fig. 3, which was in general use until the advent of smokeless powder, which possessed the necessary qualities for the attainment of accelerating combustion with the multi-perforations of Rodman. But smokeless powder required entirely new processes and apparatus for its manufacture.

Those interested in the subject may readily ascertain, by reference to the Reports of the Chief of Ordnance of the United States Army that the Maxim-Schupphaus smokeless powder, invented by Dr. Schupphaus and myself, was the first smokeless powder in which the invention of Gen. Rodman for effecting acceleration of combustion by means of multi-perforations was revived and utilized, whereby the minimum of area is presented to the flame of ignition with maximum of area at the instant when the perforations have burned to their largest diameter and become tangent with one another.

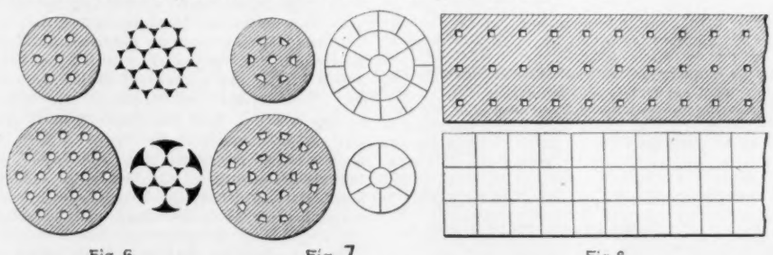


Fig. 6. Fig. 7. Fig. 8.

FIGS. 6, 7, 8.—MULTI-PERFORATED SMOKELESS POWDERS AND DIAGRAMS, SHOWING MAXIMUM COMBUSTION AREAS.

The following is quoted from the Report of the Chief of Ordnance, of 1896, page 197:

All things considered, the perforated cylinder or disk proposed by General Rodman many years ago, and recently revived in the Maxim-Schupphaus powder, appears to me to be the most suitable and promising form for the colloidal smokeless powders.

The die shown in Fig. 4, which forms the subject matter of my United States patent, No. 538,618, was devised by me for molding smokeless powder into the multi-perforated cylinder, also shown in the figure. No claims are made in the patent for the multi-perforated cylinder itself, as this form of grain was no longer new.

It appears that Gen. Rodman never patented his inventions in gunpowder, but a United States patent was applied for in 1882 by Norman Wiard, for tubular and other forms of powder grains, including multi-perforated cylinders, as shown in the group, Fig. 5, and which form the subject matter of his United States patent No. 273,209 of 1883.

In Fig. 6 are shown two cylindrical smokeless powder grains in cross-section, one with seven holes, and the other with nineteen, with diagrams at the right showing when the combustion area has reached its maximum.

In Fig. 7 are shown cross-sections of cylindrical Maxim-Schupphaus grains with the perforations made angular instead of round, to effect combustion from parallel surfaces through equal burning thicknesses, so that the maximum area will be reached at the instant of the complete consumption of the grain, as shown in the accompanying combustion diagrams. Fig. 8 is a section of a rectangular bar of Maxim-Schupphaus powder pierced with rectangular perforations, also accompanied with combustion diagram.

Many marked copies of London periodicals have recently been sent to editors of American papers and others containing articles claiming Mr. Hiram S. Maxim to be the inventor of both tubular and multi-perforated powder grains, and the originator of the whole idea of accelerating or progressive combustion. Such claims appear extraordinary in view of the great work done by Gen. Rodman and others, and to whom the real credit belongs.

A peculiar feature of the matter is that a person claiming to be a patent expert, Thomas A. Hill by name, is purported to have been engaged to examine the patent records and all the facts in the case and report thereon for the information of the editors of the said periodicals prior to the publication of his report, with editorials for the benefit of the public. As marked copies of these periodicals have been sent out in large numbers with a view to disseminating the information, it will be of interest to those who have been thus favored with copies, and others who have seen the articles, to know what a curious light the actual facts in the case throw on the whole matter.

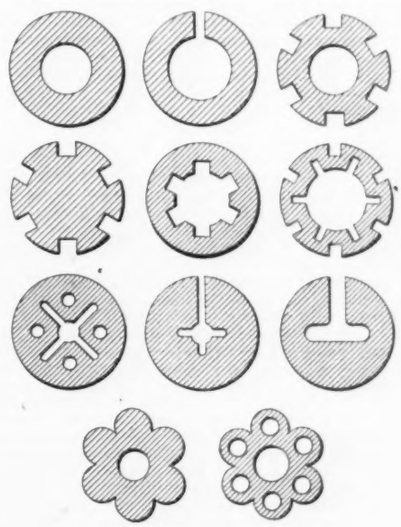


Fig. 9.

Fig. 9.—Perforated Powder Grains, Shown in British Patent No. 17,994, of 1894, Issued to Hiram S. Maxim.

(Patent applied for Sept. 21, 1894, nearly 40 years after invention of grains shown in Fig. 1; 12 years after invention of grains shown in Fig. 5, and 8 months after patents of Hudson Maxim (Fig. 4).

Mr. Hill cites the British patent of Hiram S. Maxim, No. 17,994, of 1894, in which are shown and claimed the tubular and other forms of grains illustrated in Fig. 9, for the purpose of accelerating combustion. Mr. Hill then cites four of my United States patents, Nos. 538,618, 540,326, 540,327 and 540,328, for the die illustrated in Fig. 4, and for cartridges, in which multi-perforated grains are shown but not claimed. These patents, Mr. Hill says, were not applied for "until after 1895," and about a year after the above British patent of Hiram S. Maxim. On referring to these patents, it will be seen that they were filed in the latter part of 1893, and the beginning of 1894, about eight months earlier than the application of Mr. Hiram S. Maxim for the English patent referred to. But this is no more extraordinary than the fact that the United States patent of Wiard for the grains shown in Fig. 5, and the multi-perforated grains of Gen. Rodman are ignored altogether. Furthermore, the forms of grains shown in Hiram S. Maxim's patent are far inferior to the earlier inventions of others shown in the accompanying illustrations for the purpose of effecting acceleration of com-

bustion, especially the multi-perforated grains invented by Gen. Rodman more than forty years ago.

As Mr. Hill is a patent expert and must have had all the patents before him, it would be an injustice to his professional skill to presume that he made these misstatement through ignorance. In view of the actual facts in the case which I have here presented, I believe that many readers will guess that there is someone with a motive standing in the background. Cherches l'homme avec le motif.

Very truly yours,

Hudson Maxim.

891 Sterling Place, Brooklyn, N. Y., April 13, 1900.

Pavement Foundations in Albany, N. Y.

Sir: In your issue of April 19, you refer to the objections made by the Mayor of this city to brick pavements. I think that you have mistaken the import of the Mayor's message to the Common Council, however, for he says:

> Brick pavements have become very popular with our people. I don't know how practical it would be to lay them on sand foundation. I have heard this is done in some Western cities, and also Troy, N. Y., has some brick on sand foundations.

The object of the Mayor's message seems to have been to request the Common Council to examine into the advisability of reverting to the use of sand as a foundation for granite pavement and of employing the same foundation for brick pavements if this is practicable.

Since the matter of pavement foundations is of more than local importance, it is probable that those of your readers who are interested in the matter of street pavements may wish to know some of the facts regarding Albany's experience. The soil in Albany is very generally clay, except in the west part of the city, where fine "blow sand" is met with; most of this sand will pass through a 50-to-the-inch screen. The clay makes about as poor foundation for a pavement as it is possible to find. The amount of moisture in it is quite variable and its supporting power varies accordingly. It is liable to be interspersed in places with veins of fine sand which, when wet, flows readily, forming a bad quicksand. There is also much filled land in the older parts of the city and the filling is far from being uniform either in material or in consolidation. The use of cobblestones on a sand foundation was quite universal until about 1875, when granite blocks were introduced.

Not until asphalt was laid, in 1889, was concrete used as a foundation. In 1891 granite pavement was laid on concrete and there are now about 69,000 sq. yds. of this pavement on concrete. Brick pavement was introduced in 1894, and there are now 281,000 sq. yds., all on concrete. There are also nearly 164,000 sq. yds. of asphalt on concrete.

The Mayor seems to have become convinced that concrete is a foundation of superior excellence, for he says: "Theoretically it may be regarded as an admirable example of municipal work." His objections in part seem to be that pavements laid on concrete cannot be easily taken up and replaced and that it is difficult to locate breaks in sewers and in water pipes. These objections are not at all novel and are sufficiently obvious. It is contended, however, by most engineers of experience that the advantages of concrete will outweigh such objections and that with proper insistence repairs can be made without undue expense, and that they will be better repairs than if sand is used as a foundation. The objection made by the Mayor, that concrete adds materially to the cost of the pavement, is not so evident. Coarse sand, suitable for pavement foundations, is costly in Albany; and the difference in price between 6 ins. of concrete and 14 ins. of sand, when taken in connection with the difference in the excavation, will make the cost of granite on concrete but little more than if it were laid on sand. As a matter of fact, the average cost of all the granite laid with watertight joints on a concrete base has been about $2.95 per sq. yd., which price was exceeded in a number of instances by that of granite laid on 14 ins. of sand and with sand filled joints. The importance of rendering pavement water-tight by properly filling the joints, both for the proper preservation of the pavement and for improving the sanitary conditions, is now conceded by the adoption of pitch or cement filling for the joints of block pavements throughout the civilized world.

The really important question then to consider is: Can repairs to pavement with concrete foundation be well and cheaply made? In order to avoid the increased cost as well as the annoyance and vexation of several assessments it has become usual and quite popular to replace old sewers and house drains under the same contract as that for paving the street. This procedure has several points in its favor besides the financial ones. The assumption that it is better practice to lay a sewer or water pipe one or more years before the street is paved is not always a true one. When a contractor lays a pipe in a poorly paved street, he is little apt to take much care with his back-filling, for he can cheaply repair any settlement, and it takes a large settlement to be very perceptible; besides he is limited to the use of the material excavated for his back-filling. A paving contractor is not responsible for a settlement over a trench dug by someone else a year or more before he commenced his work, yet a badly filled trench in clay will often settle for many years.

On the other hand, a contractor laying pipes just before paving and under the same contract feels the responsibility of his guarantee of the whole work for a period of five years. In making his back-filling he can just as cheaply remove material inproper for that purpose and replace it with the best of the sand and earth found under the old pavement. For some years the practice has been to pay the contractor for the days' labor in ramming back-filling of trenches, so that he is under no temptation to shirk this work from any motive of saving. The final rolling of the subsoil with a heavy steam roller has also been insisted on for several years, the city having purchased a roller for that purpose.

There are many streets in Albany which have been very thoroughly trenched in every direction immediately before paving, where the street surface is almost intact, while there are others where sewers or water pipes were laid a year or more before paving in which bad settlements are to be seen. Most of the bad spots in our pavements are caused by cuts made after paving, and the writer contends that such cuts can be better repaired where the foundation is of concrete than if the foundation is of sand. The cost of a repair would be a little greater in the case of concrete foundations but need not be at all excessive. As a matter of fact, such repairs are made without any trained supervision and generally with the merest pretence of inspection.

All the brick pavement in the city is still under guarantee of maintenance by the contractors and in most cases repairs of all kinds are to be made by the contractor during the period of his guarantee, at prices fixed in the contract, but frequently this provision has not been enforced. To ensure a good repair in our soil it is frequently necessary that all the material excavated should be carted away, especially if it is wet and sticky clay. Other material, such as steam cinders, sand, or what is termed "hard-core" in London (the imperishable part of the rubbish from the removal of buildings), should be used in the place of the material so removed. The old concrete should be well broken up and washed, with new broken stone added if necessary, and should then be used for the making of new concrete, which should be mixed with even greater care than for the original material. The bricks or granite blocks should then be carefully cleaned and any deficiency in perfect specimens made good with new, and be carefully replaced by skilled workmen on a proper sand cushion, and the original bond should be carefully retained. Afterwards the joints should be filled with hot paving pitch, whatever may have been the material of the original filling. After a period of two days traffic could then be allowed on the place repaired.

The above suggestions as to the method of repairing a cut made in a pavement do not claim to be complete, but are as specified in most of the contracts for brick pavement in this city and are in general neglected in every particular. I believe that the best practice in other cities has shown that what we need is a higher standard of excellence in the making of repairs and not cheaper and more easily removed foundations for our pavements. The writer has prepared over 60 separate specifications for brick pavements, and has seen over 16 miles of pavements laid under them, and holds that one of the chief merits of brick pavement is that when it becomes worn out it can be replaced on the old concrete, with a newly surfaced sand cushion, at a smaller expense than for any other equally smooth and pleasant pavement, and such a resurfaced pavement should be smoother and more regular in contour than it was originally.

It is said that such resurfacing is intentionally done in the city of Magdeburg, where the original stone block pavements are always torn up at the end of two or three years and repaved permanently.

As to the difficulty in locating leaks under concrete, it may be pointed out that in this latitude all the soil acquires a stone-like hardness, from frost, for several months each year and at such times the removal of pavement laid on sand foundation is quite as difficult as if it had been laid on concrete. Repairs in the winter months must in any case be temporary in their nature. Leaks in gas mains are especially apt to be revealed during the winter.

Very truly yours,

Horace Andrews, M. Am. Soc. C. E.

Albany, N. Y., April 31, 1900.

Notes and Queries.

In the column of "Trade Publications" in our issue of April 12, a circular of the "Climax" Flexible Metallic Joint was noted, but the name of its manufacturer was incorrectly given. The makers are the John Davis Co., 51 to 79 Michigan St., Chicago.

Mr. H. M. Wilson, of the U. S. Geological Survey, calls attention to the fact that while his recent work, reviewed in our issue of April 12, is entitled "Water Resources of Puerto Rico," the official name of the island will henceforth be "Porto Rico." This change is effected by the recent act of Congress and reverses the ruling of the National Board on Geographic Names, which fixed the Spanish form as the official standard.

THE IRON ORE DEPOSITS OF DUNDERLAND, NORWAY.

By H. L. Geissel.*

The Dunderland Valley is situated at the upper end of the Ranenfjord, Norway, and contains iron ore deposits of great magnitude.

Although their existence has long been known, it is only within the last few years that the district has been thoroughly investigated by well-known experts at the instigation of the Norwegian Government. Their reports are unanimous in the statement that the iron ore deposits are not only extensive but also exceptionally rich.

The Dunderland Valley is situated south of the polar circle (66° 30" N. Lat.), and the deposits appear to occur in the same circle from west to east for something like 12 miles, with varying widths of the lodes. The valley is intersected by the Dunderland River, and on both sides mountains rise to a respectable height of 2,500 ft., with such peaks as the Urtfjeld, 4,000 ft., and the Bredikjeld, 4,150 ft. high. The ore deporits are chiefly found on the north side of the river, but are also traced on the south side for a quarter mile to a mile from the waterway.

The geological formation of the valley is glacial, post-glacial, and cambrian, with huge lime deposits in which the iron ore is found. The deposits are located in six districts, viz.: Vesteraalid, Bjornhei, Urtvand, Lilleaaen, Strandjord, Nord Dunderland. These deposits are practically all connected for a distance of 15 miles, and are mostly from 50 to 100 ft. in width. Taking the deposits at 600 ft. in height from the level of the river, no less than 840,000,000 tons of iron ore may be available there.

In such a vast bulk of iron ore it cannot be expected that the entire quantity should be high grade ore, but it is said on reliable authority that 25%, or 200,000,000 tons of ore represent a very good quality, containing from 55 to 65% of iron.

The rock formation is mostly quartz, with some small quantities of pyroxene, amphibol, epidote, granite, mica and feldspar. The quantity of phosphorus found differs somewhat in the various lodes, but the average is not thought to exceed 0.15%, but in most of the samples it has been so little that the ore is suitable for bessemer working. Analyses of the ore are as follows:

	Tunnel I.	Tunnel II.
Fe_2O_3	82.21	68.63
Fe_3O_4	5.07	4.23
SiO_2	8.00	20.35
Al_2O_3	1.06	1.79
MnO	0.21	0.27
CaO	2.70	3.60
MgO	0.29	0.75
P_2O_5	0.121	0.565
S	0.010	0.025
Total	99.67	99.81
Fe	61.32	50.63
P	0.053	0.248

The working of the Dunderland deposits, in the sloping hills, will be exceedingly simple, as the ore is only hidden beneath a thin crust of earth covered with birch trees, and no pumps or shafts will be necessary. It is estimated that the ore will cost 36 cts. per ton on the bank, or 66 cts. f. o. b., Ranenfjord. Although situated just below the Polar Circle, the climate of Dunderland is mild and pleasant; the Gulf Stream checks the severity of the winters, and the Ranenfjord is open for navigation throughout the year. A good natural harbor exists for ships up to 3,000 tons; the difference between high and low water is from 4 to 6 ft. It is said that the Dunderland iron ore deposits are far more advantageously situated than the well-known Swedish iron mines at Gellivara.

The Dunderland Valley is exceedingly picturesque, and the neighboring Svartisen glacier attracts from year to year a large number of tourists, who have no difficulty in reaching the spot, as there is regular steamboat communication with England and Scotland, from which it can be reached within 48 hours.

The district abounds in water power, which can be utilized for electric light and other industrial undertakings. The Renfos is 90 ft. high and with its abundant water supply is estimated to yield 5,000 HP. The Storfos and Stubfos and the Dunderland falls are each estimated to produce 3,000 HP.

Timber is plentiful, and the whole district is

*233 South 4th St., Philadelphia, Pa.

in regular post and telegraphic communication with all parts of Norway. Labor could easily be obtained, as provisions are cheap and plentiful. A great number of farmers' houses suitable for workmen's residences are available throughout the valley.

NORTH CHINESE RAILWAYS are reported upon by U. S. Minister Conger to the State Department. He says that the Tientsin-Shanhaikuan-Niuchwang branch of the Imperial Railways is completed. The distance from Tientsin to Niuchwang is 348.6 miles; and on the 268 miles from Tientsin to Chinchow, over which trains have been running for some months, the revenue already pays 14% on the capital invested; the completed line is expected to pay 30%. The Russian Chinese-Eastern Railway is completed from Port Arthur north to Monkden, a distance of 180 miles; it connects at Niuchwang with the road to Pekin. Russia is hastening work on the line north and hopes to reach Vladivostock in August of this year. On the Siberian railway trains are now running east to Stretensk, on the River Shilka, a tributary of the Amur; from this place the river route is used to Khabarovsk, on the Uszuri section of railway leading to Vladivostock. At present the time consumed in transit over the Siberian route is: St. Petersburg to Lake Baikal, 9 days; Lake Baikal to Stretensk, 3 days; by river to Khabarovsk, 6 days; rail to Vladivostock, 1 day; total, 19 days. The Russians expect to have the railway between Stretensk and Vladivostock open in about 18 months.

THE ENGINEERING EXHIBIT OF THE STATE OF Massachusetts at the Paris Exposition will occupy a space of 19 × 29 ft. The most pretentious as well as most interesting thing in this exhibit is a plaster model of the Metropolitan district, on a scale of 5 ins. to the mile, with the vertical scale exaggerated six times. It is the work of Mr. George C. Curtis, of Boston, and required the services of some 20 people for about eight months in its construction. It is 10½ ft. in diameter and weighs about a ton. The problem of transportation of this model without breakage is one demanding much consideration. It has been finally decided to bolt a cover over the plaster model, and then to suspend the whole within a heavy case by means of car springs, so as to approximate as nearly as possible to the conditions that would obtain if it were suspended in a liquid. On the outer case will be securely bolted a wheeled truck, so there will be no excuse for rolling the case over. With these precautions it is hoped that no more serious damage will result than the breaking off of a few church steeples or factory chimneys, which can easily be replaced. There is in contemplation a small model showing the Lawrence Experiment Station of the State Board of Health. The Metropolitan Water Board and Metropolitan Sewerage Commission have prepared extensive wall exhibits of maps and photographic enlargements. The water board's map is a topographical map of the whole State, excepting Cape Cod, and measures about 8 × 13 ft., the scale being one mile to the inch. On it are shown the Metropolitan water district, and the various drainage areas from which water is now or may be in the futnre obtained. The photographs show different parts of the works. The exhibit of the Sewerage Commission is similar in scope, the map being of the district around Boston, in which all its works are situated. Both of these boards have also prepared monographs describing their works, a limited number of copies of which have been printed for distribution to engineers at the Exposition. Similar monographs have also been prepared describing the Metropolitan park system, and the street railways of the State. The whole exhibit has been prepared under the direction of the Massachusetts Board of Paris Exposition Managers, of which Mr. Walter S. Allen is secretary and executive officer. Mr. Andrew D. Fuller, Jun. Am. Soc. C. E., will be in immediate charge of this exhibit during the exposition.

THE DISASTER TO THE WATER POWER PLANT AT HANNAWA FALLS, N. Y.

For nearly a year, work has been in progress on the development of a large water power plant on the Raquette River, at Hannawa Falls, a few miles south of Potsdam, N. Y. The work has been carried out by the Hannawa Falls Water Power Co., of which Mr. W. B. Cogswell, M. Am. Soc. C. E., Vice-President of the Solvay Process Co., is President, and Mr. Wallace C. Johnson, M. Am. Soc. C. E., of Niagara Falls, N. Y., is Chief Engineer.

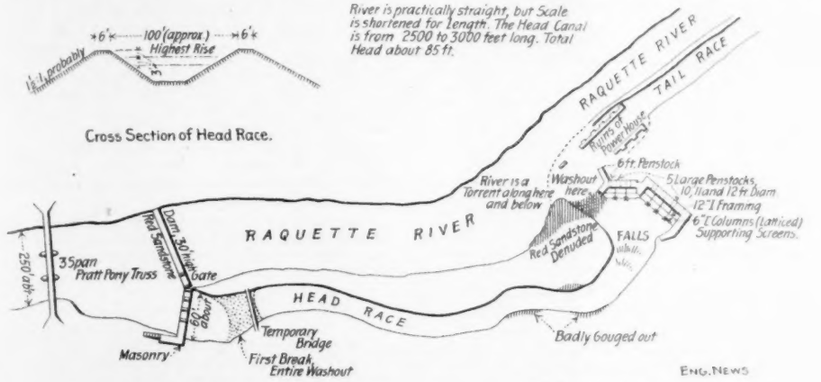


FIG. 1.—SKETCH MAP OF HANNAWA FALLS WATER-POWER PLANT.

(Compiled by Prof. J. H. Griffith from pencil sketches on ground; data furnished by Surveyor Smith and county map.)

Briefly described, the works consist of a masonry dam across the main channel of the river, diverting its flow into a canal or head-race. This canal extends along the sides of the valley for about half a mile and terminates in a masonry chamber or forebay. This is located on top of a rocky bluff close to the gorge in which the river runs. At the base of this bluff is the power house, designed to take water from the forebay through steel penstocks and discharge it into a tail race, which empties into the main river channel some 1,500 ft. below the power house.

The dam, shown in Fig. 2, is a substantial-looking structure, 325 ft. long and 35 ft. high. Its crest is designed to act as a waste-weir in time of flood. A sluiceway, seen at the left in Fig. 2, is provided for controlling the level of the water behind the dam. Both the dam and the canal, which leads from a point just above it, were completed last fall, except for a narrow strip of earth at the head of the canal, which was left in place until the works should be completed. It was the giving way of this bank of earth on the afternoon of April 18 which caused the disaster to the works below.

Above this bank of earth, at the head of the canal, head-gates were designed to be placed, in order to shut the water out of the canal when desired, and the masonry piers for these gates were erected, but the gates had not yet been put in.

The masonry forebay at the lower end of the canal is seen in Fig. 4, the cut being reproduced from a photograph taken last fall. The head-gates controlling the penstock openings were in place and closed at the time of the accident. The power house at the foot of the bluff below the forebay was about half completed, and some two hundred workmen were engaged upon it when the accident occurred. They were fortunately warned in time to escape.

On Thursday, April 19, 24 hours after the break occurred, the scene of the disaster was visited by Messrs. John H. Griffith and Edward Robinson, Professors of Engineering in the Clarkson School of Technology at Potsdam; and they have furnished to us the following report of their investigation. The photographs which are herewith reproduced, except Figs. 2 and 4, were taken by Prof. Robinson on the day of his visit:

Sir: We herewith send data as to the Hannawa Falls disaster on April 18. It would seem from newspaper accounts that the matter has been greatly exaggerated. Your correspondents examined the current of the Raquette River about an hour after the break at a point some miles below the dam. The flow was swift, but about 10 ft. below high water mark. The river is not as high as it was a year ago at this time.

From the best accounts the trouble began about 1 p. m., when a slight leak was found in the barrier of earth at the upper end of the canal, or head race. The matter was immediately reported and efforts were made to control the flow of the water by placing obstructions in front of the masonry piers for the headgates. A large amount of water, however, passed through, and rushed like a tidal wave down the head race, striking the forebay at the lower end with a tremendous shock. The forebay masonry, however, was founded on solid rock, and it received no appreciable damage. The screens in front of the penstock openings, made of 3 × ⅜-in. bar iron, were somewhat twisted from the shock, but the iron framework, gates, etc., are entirely firm. The gates are of 8 × 8-in. oak, with

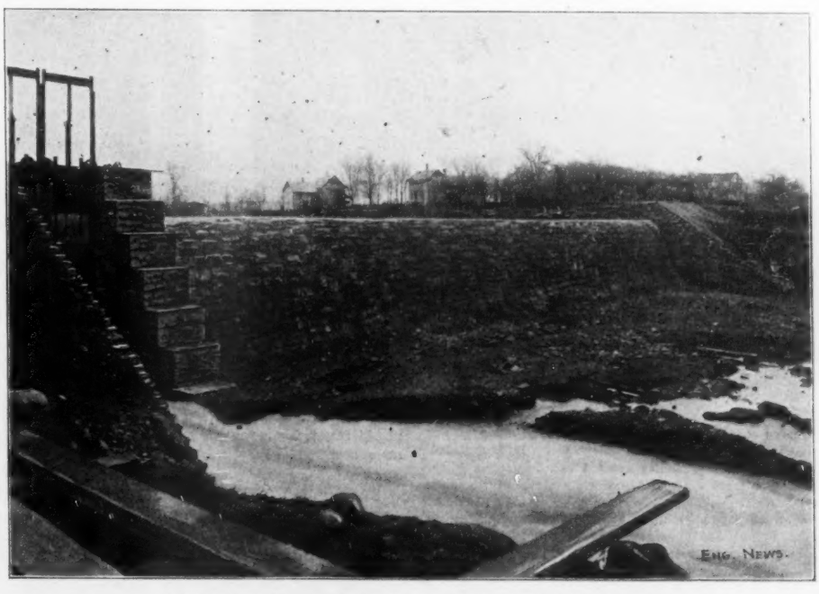


FIG. 2.—MASONRY DAM IN RAQUETTE RIVER, AT HANNAWA FALLS, N. Y.

rack and pinion movement and valves. No effect of the immense pressure is visible. When the current of water struck the masonry at the forebay it was thrown up, it is said, to a height of 40 or 50 ft., and was diverted toward the spillway side by the form of the forebay. It is also said that the receding wave met another wave coming down the canal, so that the resultant shock must have been severe. There was, we believe, some effort made (in the intervening time before the final disaster) to strengthen certain portions of the work. From the best

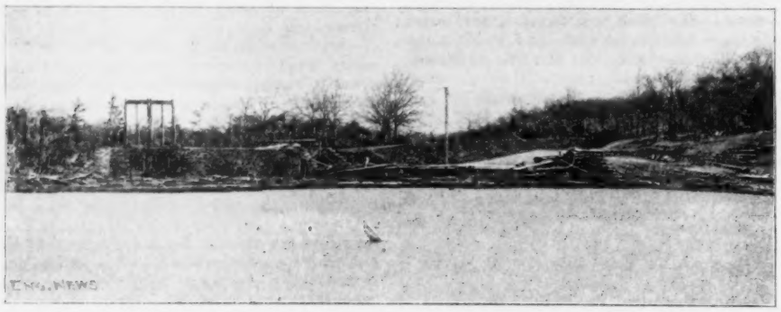


FIG. 3.—VIEW LOOKING DOWN WATER POWER CANAL FROM POND ABOVE DAM.

data that we can secure there was very probably a slight seam of quicksand between the rock ledge and the hard pan above, upon which the earth bank of the canal rested. At any rate, the bank was forced out at the bottom slowly enough for the numerous laborers on the power house below to escape drowning. This break occurred about 2 o'clock. The top of the bank was undermined and the pent up waters rushed down upon the power house, as shown in Fig. 5. A small spur of masonry forming a spillway for the forebay was damaged to some extent, and was being further undermined by the torrent at the time of our visit. Some damage was done to the banks of the canal, examples of which are shown in Fig. 7, but can be easily repaired.

above account. The chief point of interest in connection with the disaster seems to center about the head works. Apparently a narrow bank of earth left unexcavated at the head of the canal was the sole reliance to keep the waters of a rising flood from entering it. The foundation and piers for the headgates beyond this bank had been built, but the gates themselves were not in place. The hurried attempts to improvise a cofferdam across these headgate piers when the leak in the bank was discovered were futile. When the bank gave way, it broke suddenly, as it is in the nature of earth dams to do, and the flood which poured down the head-race did quite as little damage as could be expected, considering that the channel through which it flowed was formed by earth embankments intended to withstand only a gentle flow of perhaps three or four feet per second.

We may add in connection with the mention of Mr. Wallace C. Johnson's name as the Consulting Engineer of the water power company,

FIG. 4.—MASONRY FOREBAY ON BLUFF ABOVE POWER HOUSE.
(View taken in Fall of 1899.)

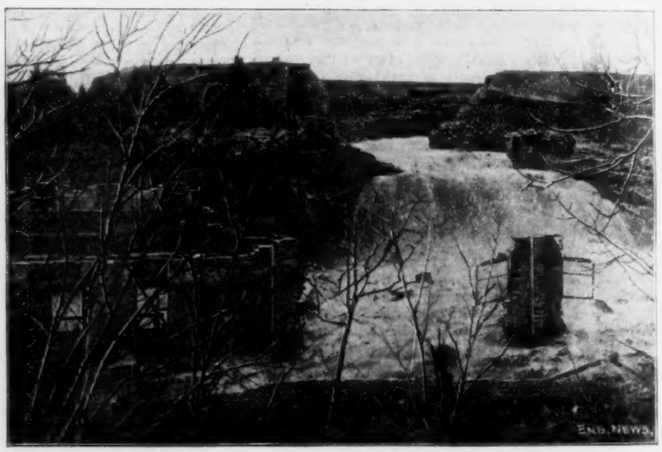


FIG. 5.—BREAK IN FOREBAY AND TORRENT RUNNING THROUGH POWER HOUSE, APRIL 19, 1900.
(View taken from opposite bank of river.)

The power house masonry was founded on rock, but has suffered considerably. The end walls had not been put in, and the other walls were only partially completed. Perhaps half of the masonry erected has been torn down. More or less machinery and materials were in the path taken by the torrent, and the river contains odd pieces of iron, such as angle bracing, penstock plates, etc. It is understood that the penstocks are in the main undamaged, only sections being carried off. The largest loss will be to machinery in the track of the torrent and machinery in the power house, but its amount cannot be ascertained as yet.

It would seem as if the accident were one of those events which are liable to befall any great engineering undertaking. While the present loss is unfortunate and to be deplored, it will be to the ultimate gain of the enterprise. The ledge of rock has been swept clean, affording a most perfect foundation for the new work at the forebay. The weaknesses of the system have been revealed with a comparatively small loss, and the safety of the final works will doubtless be better assured than would have been the case had the accident not occurred.

The photographs accompanying tell their own story so clearly that we need add little to the that Mr. Johnson has been seriously ill with typhoid fever for a month past, and so can have had no recent active connection with the work.

BOX CARS WITH END DOORS are being built for the carriage building firm of Giesenkamp, Sons & Co., of Pittsburg, Pa., for convenience in loading carriages. The cars are of the large size, commonly used for carrying furniture and carriages, but additional height is given by dropping the framing so that the drawbars pass through the end sills. The end doors give an opening the full inside width and clear height of the car, and there are also the usual sliding side doors. The cars are being built by the Youngstown Car Co., of Youngstown, O.

THE JESSUP EXPEDITION has sailed from San Francisco bound to Northwestern Siberia. It is sent out by the American Museum of Natural History of New York. The American member, Mr. Norman C. Buxton, will confine himself to the zoological field, collecting birds and mammals for the Museum. The two Russian members of the expedition, Waldemar Gogaras and Waldemar Jackelson, will study the languages, songs, customs and physical characteristics of the natives, and attempt to determine whether or not the American Indian is descended from Asiatic stock.

SMOKE PREVENTION ON THE RAILWAYS ENTERING CHICAGO.*

At the October, 1899, meeting this committee was appointed to investigate and report upon what is now being done in the matter of smoke prevention by the various railways entering Chicago, and what lines should be followed to accomplish the results sought after. Your committee has found this to be rather a difficult undertaking, especially the last portion of the instructions, as there seems to be quite a diversity of opinion among the different motive power officers as to the value and merit of the various devices advocated for the purpose of preventing smoke. Some arrangements are endorsed heartily by certain parties and are pronounced worthless by others, while it is positively known that possibly the best example of smokeless firing is given by a road that uses no device but the brick arch. This being the case, it is difficult to make any definite recommendations as to the feasibility of mechanical contrivances, some of them being so preposterous and unmechanical that they could hardly be seriously considered.

In order to get a complete list of the different methods adopted by the various roads entering this city, a circular with a list of questions was sent to the motive power departments, and many of the replies were very full and complete.

With the exception of the brick arch, which is quite generally used, the air injector (or jet of air forced into the firebox through openings through the water space) seems to be the favorite method of smoke reduction, though some claim that it is more of a smoke diluter than a smoke consumer. Most roads using these air jets report successful results when they are propertly manipulated, and particularly when used in connection with a brick arch. They are not claimed, however, to produce economical results, partly due, no doubt, to the fact that the air is more or less cold when it enters the firebox. There are some suggestions for heating the air before it is forced into the firebox, but most of the methods suggested seem to your committee to be impracticable. Several roads reported that their trials of these air jets had been unsuccessful, and especially when used without a brick arch. One superintendent of motive power says:

I have not said as much in respect to the brick arch as I really think it deserves. I think that drawing air through the fire instead of over it, and having a brick arch that will equalize the heat of the gases and make a combustion chamber behind it, will do a great deal to prevent smoke and produce a more nearly complete combustion of the coal.

All the steam jet devices are more or less copies of the old idea known as Clark's steam jet, although having a number of other trade names. They are all effective in reducing smoke, although this is done, I believe, at the expense of economy in coal consumption. The efficiency of these devices also depends upon the intelligence with which the firemen handle them, and it may be truly said that an effective smoke prevention is very largely in the hands of the fireman.

Authorities on combustion seem to agree that steam is not a good thing to introduce in the fire, and that in introducing air, as under an induced jet, there is no

*Abstract of a committee report presented at the April meeting of the Western Railway Club.

real combustion, unless the air is heated up to about the temperature of the gases in the firebox.

In regard to the new engines built for service in and around Chicago, practically all the roads are equipping these engines with one or more of these devices, mostly consisting of brick arches and air jets. In addition, some of the roads are providing boilers with large grate areas and heating surfaces, the grates in some cases being as wide as 6 ft. Of course, only certain types of engines permit this arrangement, and its use is limited. A firebox over 10 ft. in length is handled with difficulty, so that there is practically a limit to the size of grate, unless a special construction like the Wooten is adopted, and this type has some disadvantages.

The smoking of coals depends largely upon their composition. Those high in fixed carbon and low in volatile matter, like the Pocahontas, of southwestern Virginia, will produce little smoke. The Pocahontas is, in fact, advertised as a smokeless coal. It contains from 75 to 80% of fixed carbon, and about 20% of volatile matter. The Illinois coals have about half as much fixed carbon and twice as much volatile matter. It is not always the fact, however, that the best coal for heating is the freest from smoke. Coal in the fine or slack condition will generally be more difficult to control in this direction than if broken in proper sized lumps, because there is less opportunity for the air to pass through the grates.

nized every few minutes and the supply of air regulated principally by the dampers; the blower and smoke consumer must be ready for instant use on the closing of the throttle, as this is the time that the greatset volume of smoke is likely to be produced.

In order to effect these results, however, the motive power officials must perform their part. Fire doors should be at a convenient height and of a suitable size, the steam gage should be in comfortable view, both by day and night, the blower or smoke consumer valves should be quick acting and convenient of access from the foot plate, and water gages should be arranged for constant observation. Sloping sides to the tank, and coal properly broken up, will also facilitate the work so that the man with the shovel can give his complete attention to firing and other necessary duties. Many engines are so inconveniently arranged in the cab that it is almost preposterous to expect and ask good results, and a ride on the engine will often show the unintelligent manner in which the fittings have been placed.

The brick arch should be properly located, and if smoke consumers in the form of air or steam jets are determined upon, they should be maintained in good condition. Intelligent instructions should be given to all enginemen, and they should be taught and expected to take an interest in the results of their work. Individual fuel reports will show the economy of the different crews, on

methods in use on the Burlington, Cedar Rapids & Northern Ry., and which are practically the same as those already suggested in the foregoing report. In 1892 the Illinois Central R. R. issued this notice to enginemen:

All engines running into Chicago are to be equipped with smoke consumers, and it is very important that enginemen use them whenever necessary for the prevention of black smoke within the city limits of Chicago. Those who do not fully understand the working of this device will call upon the master mechanic or inspector, who will give them the necessary information. It is the duty of enginemen to see that smoke consumers are used and kept in proper condition, and they will be held personally responsible for the condition and operation of the same, as well as any violation of the "Smoke Ordinance."

Other circulars and bulletins of this nature have been issued from time to time by the various railways. It should be borne in mind that many of the larger roads running into Chicago use from 500 to 700 tons of coal per day, and the difficulty in obtaining at all times the desired quality of fuel, can readily be appreciated. Then, of necessity, new firemen must occasionally be employed, and good results can hardly be expected from inexperienced men.

The question naturally arises: How does the smoke nuisance and its treatment in Chicago compare with other cities? The statutes of the city of Cincinnati are practically identical with those of Chicago, yet we find that few roads entering that city use any special device for

FIG. 6.—VIEW FROM INSIDE FOREBAY LOOKING OUT THROUGH THE BREAK TOWARD THE POWER HOUSE.

FIG. 7.—VIEW FROM BANK OF CANAL LOOKING TOWARD FOREBAY.

The railways entering Chicago use a great variety of coals. Those roads running east and south naturally draw from a different territory than those extending to the west and northwest. One road reports drawing altogether from over one hundred mines, and in times of a scarcity, the inferior grades are of necessity bought for consumption in this neighborhood. Some roads in the East have the advantage of coke and anthracite where the prices are as low or perhaps lower than bituminous coal, but they would be practically prohibitive for railways here, even more so than for factories, as many of the former burn upward of 1,000,000 tons a year. Some of the Eastern roads advise that they have difficulty, and, in fact, cannot obtain a sufficient quantity of coke for their needs. Under these conditions the outlook for coke fuel in the West is not very encouraging, until some new sources of coke supply are available at low cost.

The importance of careful firing is recognized by all the roads reporting to your committee, the general sentiment obtaining that a good fireman without a special device is productive of better results than any of these devices poorly managed. Nearly all of the roads have not only issued concise instructions to their engineers and firemen from time to time, but it is a common practice to select expert firemen and employ them to travel on the engines and explain and illustrate the proper methods of firing to those who are less expert in the matter. Nor can all be done by the fireman,—the engineer must also assist, both by handling the engine in an intelligent manner and by communicating constantly with the fireman. In fact, to produce the best results, there must be a hearty co-operation between those concerned. The engineer should be quick to appreciate the effects of his manipulations on the fire and regulate the "cut-off" and throttle as far as possible to produce the best results, keeping his fireman informed of his intended movements. The fireman should be on the alert to take every advantage of the physical conditions of the road or any cessation in the work and should fire lightly and regularly,—not five or six shovelfuls with a rest in between, but with one shovelful at a time and the door closed gradually—that is, left with a crack open for a few seconds until there is sufficient air to consume the fresh distillates and then closed completely, except where a damper or register in the door is employed. The gage should be scrutiniz-

similar runs, and may be considered some index to the smoke consumption obtained. In order to illustrate the methods adopted by some of the larger roads entering this city, a few extracts from their circulars to engineers and firemen are here reproduced. The Chicago & Northwestern Ry. circular, issued in February, 1895, contained this pertinent clause:

Firemen should always be careful not to put in too much coal at a time, but should fire evenly and regularly. It is not good practice for any fireman (nor is he a good fireman that will do it) to put in five or six scoops at a time, and then look at the volume of black smoke that rolls out of the stack. Black smoke is coal, and whenever this is seen coming from the stack, it means that the fireman that does it is pretty well down to the bottom of the list on coal consumption.

The instructions issued by the Grand Trunk Ry. include the following:

Firemen must fire lightly and avoid heavy firing, and the fire door must be closed after each shovelful when the locomotive is working.

Firemen must anticipate their work and supply the coal to the fire accordingly before reaching a regular shutting off point, put in a slightly heavier fire long before shutting off, so that the fuel will begin to burn and not give off black smoke when the supply of air is checked. If a stop is made at any place where green coal is on the fire, apply the blower before the steam is shut off, then as soon as the throttle is closed, open the door slightly on the latch, and reduce the blower throttle sufficient to prevent the black smoke and waste of steam through the pops.

In reference to the proper method for the distribution of the bituminous coal over the locomotive grate surface, that we may obtain the most efficient results and avoid the forming of wasteful gases which issue from the stack when black smoke is produced, a set of rules cannot be given. However, skillful firemen will not immediately upon opening the furnace door, where the fire is at the least depth on the grates and burns with the most incandescent flame, that fresh fuel scattered over such a portion of the grates will give the best results.

The Michigan Central notice is as follows:

The ordinance of the city of Chicago requires us to fire our locomotives without making any black smoke. It is imperative that we insist that all road and switch engines running in the limits of the city of Chicago, be fired on the "one shovelful system," and any failure to do so will result in the discipline of the employe at fault. We know that black smoke can be prevented by careful firing, and demand that it be done.

Besides, all enginemen are presented with Sinclair's "Burning Soft Coal without Smoke," which treats of

reducing the amount of smoke, or provide any definite arrangements on new locomotives. The firemen, however, are instructed carefully, and good results are reported. One road running into Cincinnati and St. Louis advises that "it believes with an efficient fireman more can be accomplished than with any device it has tried." Instructions to its firemen are to fire not more than two shovelfuls, preferably one, and to leave the door partly open for a few seconds after putting in fresh fire.

Another road reports as follows:

We have thus far been able to demonstrate to the smoke inspectors at Cincinnati and Indianapolis that the average locomotive can be fired with one shovelful of coal in the city limits, and where this is done it has satisfied them that we are accomplishing everything in our power.

And again, from a road running into St. Louis:

We have tried a number of the so-called smoke preventing devices upon our engines running into the union stations at St. Louis and Kansas City, but with no appreciable results as far as regards diminishing the smoke nuisance. Our best success in the abatement of smoke has been accomplished by the exercise of care on the part of the enginemen in the handling and firing of the engines inside the city limits, and the further exercise of special caution while in the train shed at Union Station, St. Louis. By such methods we have reduced the smoke nuisance to a minimum. In my opinion, careful firing and handling of the engine is the most efficient smoke preventative.

As far, then, as the western cities are concerned, it seems that more attention is given to the subject, both by the city authorities and by the railway officials, and that better results are reached in Chicago than elsewhere. Furthermore, motive power men in Chicago seem willing and anxious to solve the problem of better combustion and smoke prevention, and at the present time quite a number of interesting experiments on a practical scale are under way.

In regard to the eastern cities, Philadelphia has no law on the subject, probably due to the fact that anthracite coal is the predominating fuel in that locality. Many of the locomotives, however, burn bituminous coal. New York and Boston both have ordinances requiring furnaces to consume their own smoke; the principal roads entering these cities depend largely upon the brick arch and careful firemen, and Sinclair's book, already mentioned, is distributed and traveling firemen employed to instruct the men. The proximity of the anthracite coal fields

offers a comparatively cheap smokeless fuel to eastern roads, and yet much soft coal is used in that locality. Coke is also used, to a limited extent, and this is, of course, smokeless. The Boston & Maine R. R., which has experimented largely with this fuel, reports as follows:

Coke, as we conceive it, is the most satisfactory solution of the smoke problem of anything we have yet seen. The absence of a larger supply of this fuel at the present time is the only reason for its not being used on a greater number of our engines. Provided coke can be obtained at a reasonable price and of suitable quality, and with engines properly proportioned for burning same, I would place it first, as the best and easiest solution of the smoke problem.

In the economical burning of bituminous coal and prevention of smoke, we look upon the personal equation of our engineers and firemen as most important, and we have been and are continually laboring to raise their standard and educate them on all points connected with this matter. We have men engaged unremittingly in instructing our enginemen by classes, and also our firemen, and we are prepared to say that we think the efforts well rewarded and the results material, and commend it to others for regular diet who have not acted similarly.

In conclusion, your committee begs to state that it belives it has covered the subject assigned to it, in as full a way as is possible with the data at hand, and that it has pointed out what are the most promising lines to follow in order to accomplish the desired end. G. R. Henderson, R. A. Smart, R. D. Smith, J. C. McMynn, J. W. Luttrell.

BOOK REVIEWS.

CONDENSERS.—A series of lectures and articles upon the subject reprinted from the columns of "Power." New York: The Power Publishing Co. Flexible cloth covers; 5¼ × 9 ins.; pp. 80; tables and illustrations; 50 cts.

This pamphlet contains a very complete treatment of the subject of steam engine condensers and is written in a style that can be understood by the average engine tender. After explaining the elementary mechanical and thermal principles involved, the author describes the jet, surface, injector and exhaust steam ejector types of condensers,and discusses their advantages and disadvantages. The book contains various tables relating to steam engineering, and methods for solving practical problems are illustrated by examples. Tables of sizes, capacities, speeds, etc., of the leading steam pumps on the market are given at the end of the book.

THE NICARAGUA CANAL.—By William E. Simmons. Illustrated. New York: Harper & Brothers. Cloth; 8¼ × 5¼ ins.; pp. 335; illustrated.

This work of Mr. Simmons, while it deals very briefly with the Nicaragua ship canal and its engineering features, is a satisfactory resume of the history of the enterprise up to date. The chief value of the book lies in its descriptions of the country itself, its people and their political history, the natural history of Nicaragua and a brief outline of the religious beliefs and customs of the ancient inhabitants. The history of the canal enterprise is traced from 1550 to the present time, and the record is brought down to the route for a ship canal proposed by the late commission headed by Admiral Walker. Mr. Simmons was one of the party which went to Nicaragua with Senator Warner Miller, in 1891; and his description of the proposed route for the canal is largely based upon the experiences gathered in a tramp over the line made at that time. The story is pleasantly told and covers much useful information of a general character.

MUNICIPAL GOVERNMENT—As Illustrated by the Charter, Finances and Public Charities of New York. By Bird S. Coler, Comptroller of the City. New York: D. Appleton & Co. Cloth; 5x7 ins.; pp. 200. Price, $1.

Although dealing almost wholly with specific problems confronting the author in his official capacity this little volume is full of suggestions to the officials and taxpayers of other cities than New York. The subjects discussed are: "The City Charter," "Public Charity," "Income and Expense," "Water Supply," "Transportation," "City Development" (more especially docks and shipping facilities), "The Church in Politics," and "Political Machines." The keynote of the book is that all the affairs of the city should be placed on a sound business basis, both from a financial and engineering point of view. Full municipal ownership of the water supply of the city is insisted upon, and many of the weak points in the proposed Ramapo contract are exposed. The relative merits of bridges and tunnels between Manhattan and Long Island are discussed and a decided preference for tunnels is expressed. A point which should be of great interest to other cities is an argument in favor of excluding from the debt limit bonds issued for self-supporting public works, as is done in New York and other cities in the case of water-works. This plan would give cities a freer hand in making other classes of improvements. Most of the matter in the book has been presented by Mr. Coler elsewhere, either in magazine articles, papers read before societies or in official reports, but a public service has been done in bringing all the scattered matter together in handy form.

THE FILTRATION OF PUBLIC WATER SUPPLIES.—By Allen Hazen, Assoc. M. Am. Soc. C. E., etc. Third edition; revised and enlarged. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6 × 9 ins.; pp. 321; tables and numerous illustrations. $3.

Important additions have been made to this standard work on water purification, the first edition of which was reviewed at length in our issue of Aug. 1, 1895. The first seven chapters of the original work, which made up a little more than half of the book, have been changed but slightly in the new edition, the author stating that the experience of the past five years tends chiefly to strengthen rather than alter the conclusions there laid down. Those seven chapters related specifically to slow-sand filtration. They are followed, in the present volume, by a number of entirely new chapters, on "Turbidity and Color, and the Effect of Mud Upon Sand Filters"; "Coagulation of Waters;" "Mechanical Filters"; "Removal of Iron from Ground Waters"; and "Treatment of Wafers." Besides these new chapters, the old ones on "Other Methods of Filtration," and "Water Supply and Disease," have been rewritten and extended; some of the appendices have been revised to date and one—describing the new sedimentation basins, covered filter beds and clear water reservoir at Albany, N. Y,—has been added.

The new matter can be best described, in the narrow limits of a review of a revised book, by saying that it brings the whole subject of water purification down well into the year 1899, in a concise, clear and admirable manner. The Providence, Louisville, Pittsburg and Cincinnati experiments are reviewed; or more properly the conclusions to be drawn from them are used to elucidate the principles being laid down. Sedimentation, coagulation and mechanical filtration are given careful consideration, instead of receiving but scant attention, as in the first edition, the author now feeling that sufficient data are available to warrant full discussion and definite conclusions along these lines. thanks, it is only fair for us to add, to his own admirable work in experiments and actual construction, and to the work of Messrs. Fuller, Weston and others. Particularly useful to many will be found the appendix, "Statistics of Some Filters," which includes tables of results of operation, lists of both sand and mechanical filters in use, with important figures relating to the same, brief descriptions (text) of slow-sand filters in America, and a note on the capacity of the filter plants of the world. This capacity is placed at nearly 1,600,000,000 gallons a day, in 1899, "of which 15% is represented by mechanical and 85% by sand filters." The two classes of filters have a very different relative standing in the United States, the combined capacity of all filter plants being placed at nearly 300,000,000 gallons, "of which 18% is represented by sand filters, 79% by mechanical filters and 3% by a special type of filters."

In conclusion, we wish to congratulate both the author and the publishers for bringing out an edition which really warrants the statement on the title page, "revised and enlarged," a statement which is so often a polite fiction, and also to speak a good word for the illustrations and general make-up of the book and its reasonable price.

THE WHEAT PROBLEM.—Based on Remarks Made in the Presidential Address to the British Association at Bristol in 1898. Revised, with an Answer to Various Critics. By Sir William Crookes, F.R.S. With Chapters on the Future Wheat Supply of the United States, by Mr. C. Wood Davis, of Peptone, Kan., and the Hon. John Hyde, Chief Statistician in the Department of Agriculture, Washington. New York: G. P. Putnam's Sons. London: John Murray. Cloth; 6 × 8 ins.; pp. 272. $1.25.

A liberal abstract of the address of which this book is the outgrowth was printed in our issue of Feb. 9, 1899. In our issue following the date named we opened some editorial comment on the address by stating that it ranked "as one of the most important papers read before a scientific society for many years." Aside from the interest attaching to the general subject and such a masterly handling of facts and figures as is shown both by the address and the author's answer to his critics, there are three very suggestive lines of thought in the book: (1) The possibility of increasing the supply of nitrogen available for wheat crops by a general utilization of sewage; (2) the practicability of attaining the same end by electrical means of fixing the free nitrogen of the air; and (3) increasing the arable lands of the world by irrigation. The author seems to regard (2) as by all odds the most promising, but he deplores the waste of fixed nitrogen which "we are content to hurry down our drains and water courses, into the sea," this waste in the United Kingdom being "to the value of no less than $16,000,000 per annum." Yet he is obliged to say that "no effective and universal method is yet contrived of converting sewage into corn." Since the address was delivered, the developments in sewage purification give some little reason to hope that the utilization of sewage will be more promising in the future than in the past; but on the whole we see small likelihood of any material aid in solving the wheat problem from that quarter. The present tendencies in sewage purification are away from rather than towards sewage farming, but the so-called new bacterial processes give promise of producing sewage effluents more suitable for crops than either the crude or treated sewage of the past. Thus far, however, the most economical means of sewage disposal for large numbers of towns is some other plan than sewage farming. But it is somewhat the same here as in ordinary irrigation; when prices of agricultural products rise sufficiently it may be possible to apply sewage to crops in almost any locality, and to increase the area of lands already under irrigation from reservoirs and canals to such an extent as to be an important factor in the food supplies of the world. It looks to us as though this time would be far in the future. Nevertheless, the general problem of a shortage in wheat or other food supplies may have very important bearings on the sewage disposal problems of specific communities and on irrigation practices in many sections of the country. It often requires only a little to turn the scales in favor of an enterprise in order to make it economically practicable. As arable lands increase in value, huge storage reservoirs will become profitable investments where they would now be very risky and money can also be expended wisely in preventing the loss of water in distribution. Further still, as agricultural products increase in value, or even in uniformity of price, irrigation may well be extended in sections where it is as yet not thought of. Just at present, the low price of wheat promises little to the engineer or the capitalist who are counting on "The Wheat Problem" as a quickening force in any of the lines of development named above, sewage farming, electro-chemical engineering or ordinary irrigation.

STEAM ENGINE THECRY AND PRACTICE.—By William Ripper, M. Inst. C. E., Professor of Engineering in the University College of Sheffield. With 438 illustrations. Longmans, Green & Co., London, New York and Bombay. 8vo.; cloth; pp. 398; $2.50.

Professor Ripper is well known as the author of a little book called "Steam," which sells for a dollar, and which is probably the best elementary treatise extant for beginners in the study of steam and the steam engine. His present book is a much more pretentious work, and is anything but elementary, being designed for advanced students. It was prepared in the first instance, as the preface states, as notes for the second-year engineering students in the college at Sheffield and deals, in as simple a form as possible, with those branches of the subject which are of fundamental importance to a sound knowledge of steam engine design and management.

The first chapter treats of thermodynamics of gases. It is very brief, covering only 20 pages, but contains enough mathematics to give the student considerable work to master it. The next chapter is a short and easy one, on properties of steam; then follows 20 pages on "Temperature-Entropy Diagrams." Here the student will find matter which is not found in any but the most recent works on the steam engine, since the temperature-entropy diagram has been in engineering literature for only ten years, and it is only within the last five years that it has been considered seriously by more than a few writers. A large folding plate gives the diagram for 1 lb. of H_2O from 100° to 400° F., including also scales of pressure, volume, and dryness fractions. The definition of entropy given by the author is about the most satisfactory one that we have yet seen. It is:

Entropy is length on a diagram whose height is absolute temperature and whose area is energy, Q, in heat-units. Any change of heat received or rejected results in a change of entropy, the amount of the change being equal to the sum of the heat elements added or subtracted, each being divided by the absolute temperature of the substance at the time of the change.

As all students of the steam engine in technical schools are expected to study entropy, in the hope that the knowledge of it may some day prove useful, they will be grateful to Professor Ripper for having put the subject into a shape that is more easily understood than what has been written on it by most other writers.

Chapters on the slide-valve and the indicator follow, which are discussed in the usual manner, and then a short chapter is given on "Quality of the Steam in the Cylinder," in which cylinder condensation, range of temperature in the cylinder, condensation due to work, etc., are treated. The entropy-temperature diagram is made use of in this chapter to explain the effects of cylinder condensation. Hirn's analysis is also here given.

Compound engines are discussed in the short space of 20 pages, altogether too briefly. An excellent chapter on superheated steam follows, containing much information in regard to the most recent practice. The next two chapters discuss internal surface of cylinders, and the steam-jacket. This finishes the discussion of the theory of the action of steam in the cylinder, and all of these chapters take up less than one-half of the volume. The next ten chapters, covering 125 pages, treat of the mechanical details and accessories of steam engines, such as injectors, condensers, feed-water heaters, governors, flywheel, turning effort in the crank-shaft, engine details, friction, and balancing. Chapter XX., on "Steam Engine Performance," contains some good matter, with recent information as to the relative performance of different types of engines under different conditions. The four concluding chapters are on types of engines, the Corliss engine, the locomotive, and the marine engine.

On the whole Professor Ripper's book is good, what there is of it. Some parts of it are excellent; but there seems to be a lack of balance about it, due to the extreme brevity of some of its chapters. The chapter on compound engines might well be expanded to four times its present size, and the whole book doubled in size. If this were done the work might fill the place which has long been vacant, that of a standard $5 modern book on the steam engine. The question "What is the best book on the steam engine?" still remains unanswered. The student needs half a dozen books on the subject, and Professor Ripper's should be one of them.